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**AN EMPIRICAL ANALYSIS OF THE MARKET FOR  
MORTGAGE FINANCE  
IN THE UNITED KINGDOM**

**George Edward Buckley**

A thesis submitted to the University of Bristol in accordance with the requirements of  
the degree of Ph.D. in the Faculty of Social Sciences, Department of Economics.

**March 1999**



## ABSTRACT

The purpose of this thesis is to empirically investigate the factors which drive the demand for and supply of mortgage finance in the United Kingdom. In particular, borrowers of long term mortgage funds are especially susceptible to the effects of inflation in 'tilting' the stream of real repayments towards the initial years of the loan. As such, under certain circumstances inflation can be an important cause of mortgage default and thus plays a crucial role in the determination of mortgage demand.

The mechanism through which mortgage default leads to households being possessed by their creditors is examined empirically. The results suggest that the ability to withdraw equity from the property either by remortgaging or 'trading down' is important for borrowers who face financial difficulties. In addition, a relaxation of the non-interest terms of the mortgage contract is shown to lead to a rise in mortgage default, although this does not appear to have dampened the willingness of either mortgage borrowers or lenders to transact at high loan to value ratios.

Understanding the underlying forces which cause repayment problems gives an important insight into the specification of both the mortgage demand and supply functions. In formulating such models, it is imperative that the dramatic structural changes in the market for mortgage finance are accounted for. This is particularly true for the supply side, and a formal theoretical model of building society interest rate setting is derived in which societies choose the degree to which they are either 'member-' or 'profit-oriented'. Interestingly, the model suggests that up to a point a building society may not alter either its mortgage or savings rate if its 'preference for mutuality' were to change.

Finally, reduced form cointegrating relationships for the quantity of mortgages traded, the mortgage interest rate and the loan to value ratio are estimated. The results are used to evaluate the extent of mortgage rationing during the 1970s; this research reaffirms the findings of other papers and anecdotal evidence to suggest that disequilibrium quantity rationing was substantial prior to 1980. In fact, a regime shift in the early 1980s is confirmed by the change in the way mortgage lenders have used combinations of the mortgage rate and the loan to value ratio to restrict lending.

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## AUTHOR'S DECLARATION

The work presented in this thesis was carried out in the Department of Economics at the University of Bristol and is wholly my own. No part of the thesis has been submitted for any other degree.

The views expressed in this thesis are those of the author and not of the University of Bristol.

SIGNED : *George Edward Buckley*

DATE : *8<sup>th</sup> November 1999*

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# **CHAPTER 1**

## **Introduction**

### **1.1 OUTLINE OF THE THESIS**

The housing and mortgage markets play a crucial role in the wider economy. Given the importance of the housing asset in households' wealth portfolios, cycles in the housing market can have a significant influence on the economy as a whole, and indeed vice versa. Clearly, then, the mortgage market acting as the facilitator to the purchase of property is crucial to the operation of the housing market and other inter-related markets. Likewise, given that the majority of UK owner occupiers hold mortgage debt, the operation of monetary policy has important implications for the affordability of housing through the mortgage market. Structural developments in the UK mortgage market which have resulted from legislative changes during the 1980s have acted to enhance competitiveness and efficiency among mortgage suppliers, which in turn has had implications for the ability of the housing market to support more rapid growth, particularly during the second half of the 1980s. However, this position became unsustainable during the economic recession of the early 1990s as arrears and possessions rose, house prices collapsed and housing turnover (and thus also mortgage approvals) slowed; the changes in the mortgage market during the 1980s played no small role in the housing boom followed by this dramatic decline.

In recognising the importance of the mortgage market, the objective of this thesis is to investigate not only the factors which drive the demand for and supply of mortgage funds in the UK, but also to analyse some of the problems faced by the borrowers of long term funds; understanding the underlying forces which cause repayment problems can give an insight into the specification of both the mortgage demand and supply functions. Thus, following an examination of the institutional structure of the mortgage market, the first half of the thesis considers the mechanism through which mortgage default leads to households being possessed by their creditors; this in turn is shown to have implications for house prices. The interaction of general price inflation

with the type of mortgage design used to fund the house purchase has in the past been cited as an important factor in causing mortgage default; as such, special attention is devoted to analysing this problem.

Armed with this knowledge, the second half of the thesis estimates a model of the demand for and supply of mortgage finance across all UK lending institutions. A theoretical model of building society mortgage supply is included as a stand-alone analysis; however, given the recent trend in building society de-mutualisations, the incorporation of its findings into a contemporary econometric model proved too problematic (with regard data issues).

Specifically, the thesis is organised as follows. Chapter 2 provides a discussion of the institutional characteristics of the UK mortgage market, and a number of hypotheses are briefly investigated as to the nature of the relationship between the housing and mortgage markets and the economy as a whole. It will be seen throughout the thesis that it is particularly important to have a good understanding of the evolution of the market when it comes to specifying appropriate models of mortgage finance. Although the historical context is briefly outlined, attention is focused on the more recent developments in the market that have occurred since 1970, and particularly the important legislative and ensuing structural changes of the 1980s and 1990s. Most notably, the chapter investigates the decline in the dominance of building societies over banks in mortgage lending activity, the ending of mortgage rationing following increased competitive supply side pressures and the trends in mergers, amalgamations and conversions within the mutual sector.

As a precursor to the estimation of equations determining arrears and possessions and mortgage demand and supply later in the thesis, Chapter 3 analyses the 'front-loading' or 'tilt' problem that is generated by the coexistence of general price inflation with certain types of mortgage contract (such as the standard level payment mortgage and variable rate mortgage, currently the most popular contracts in the UK). It will be seen that in such situations, even with a constant real mortgage rate, the intertemporal distribution of *real* mortgage repayments will be skewed towards the initial years of



the mortgage term, the size of the skewness depending upon the rate of inflation. The principal implication of this repayment tilt is that for a given mortgage size, households will face more demanding real repayment schedules during the early years of the loan which will raise the probability of default for those households deciding to acquire or already holding mortgage debt. A number of alternative mortgage designs are then reviewed; the extent to which the repayment tilt remains a problem (and thus will be important in the econometric models specified in later chapters) will then be dependent on the popularity of the more effective designs.

In Chapter 4 the mechanics of mortgage default are investigated further, with cointegrating and dynamic models of real house prices, arrears and possessions proposed by Breedon and Joyce (1993) in a Bank of England working paper being examined and re-estimated. The theoretical model of real house prices is derived from a household utility maximisation model, whereas arrears are assumed to arise when a household's mortgage repayments exceed the sum of disposable income plus available unwithdrawn housing equity. Finally, the lender's decision to possess a property is shown to depend upon the current house price and the lender's expectation of both future house prices and the borrowers ability to repay the loan. The models are estimated using an extended data set from that of Breedon and Joyce (capturing the upturn, peak and subsequent fall in arrears and possessions, and also the full cycle in house prices in the early to mid-1990s) using Park's (1992) canonical cointegrating estimator (Breedon and Joyce use Johansen's (1988) procedure). The coefficients of the cointegrating and dynamic equations are shown to be reasonably robust to the precise functional specification, although some of the long run parameters are found to be sensitive to the sample period extension. It will be seen that the short run dynamic equations perform particularly well with respect to parameter stability and forecast accuracy.

Attention is directed in Chapter 5 to the development of a theoretical model of building society mortgage interest rate setting, in order that the determinants of mortgage supply may be more rigorously identified. An important issue in modelling building society behaviour is the specification of the objective function; clearly, the

assumption of profit maximisation would be inappropriate given building societies' mutual status. The first half of the chapter therefore investigates the possible use of various objective functions and, following a review of the US credit union literature (from which two testable microeconomic models are constructed), it is assumed that UK building societies choose their mortgage and savings rates in order to maximise a weighted function of member financial benefits and additions to reserves. The resultant optimal interest rate functions are shown to depend on the parameters of the behavioural equations for mortgage demand and savings supply and also the exogenous competing interest rates. A particularly interesting feature of the model is that under certain circumstances the interest rate choice will be independent of the extent to which the society is oriented towards the maximisation of either profits or member benefits (i.e. the degree of 'mutuality'). Nevertheless, the model is also shown to be consistent with evidence suggesting that conversion from mutual to Plc status is associated with higher mortgage rates and lower deposit rates.

The final two chapters of the thesis are concerned with the specification, estimation and testing of a non-stationary macroeconomic model of the demand for and supply of mortgage finance. Given the inconsistency of building society lending data following the recent trend in de-mutualisation (break adjusted data is not available from 1990 onwards), the model is estimated across all mortgage lending institutions. However, this means that the full specification of building societies' mortgage supply suggested by the theoretical model of Chapter 5 cannot be adopted empirically.

Chapter 6 details the precise specification and construction of the relevant variables used in the empirical analysis of Chapter 7. This includes the use of the Box-Jenkins (1976) framework to estimate an ARMA model in order that forecasts of expected future house prices can be constructed, a component of the real user cost variable in the mortgage demand equation. Following the discussion of a number of data issues, the series are tested to ensure that each is non-stationary of order  $I(1)$ , a necessary requirement for cointegration.



Following a discussion of the difficulties in estimating a cointegrating structural demand and supply model of the mortgage market, Chapter 7 presents the results from the estimation of the long run cointegrating reduced form relationships for the quantity of mortgages traded, the mortgage rate and the loan to value ratio over the period 1984 to 1995 (during which period the mortgage market was assumed to be in a state of competitive equilibrium). The cointegrating reduced form mortgage equation is then used to backcast the expected level of mortgages traded from the late 1960s to early 1980s, a period during which the market was characterised by a regime of disequilibrium rationing (i.e. where changes in the terms of the mortgage loan were insufficient to clear the market). The model suggests that disequilibrium mortgage rationing was substantial throughout the 1970s and estimates of mortgage rationing are presented and discussed. The relationship between the estimated coefficients in the loan to value and mortgage rate equations are shown to be of particular importance in determining how equilibrium rationing has been achieved since then. The short run dynamic estimation of the reduced form mortgage equation suggests that the adjustment to long run equilibrium is speedy for the period post-1984.

Finally, Chapter 8 presents the overall summary and conclusions of the thesis.

The remainder of this introductory chapter is devoted to reviewing the recent literature on the mortgage market. The preference is to keep the review both specific and reasonably short since throughout the thesis a considerable number of other papers are discussed in the process of constructing each model and analysing the results.

## **1.2 A REVIEW OF THE MORTGAGE MARKET LITERATURE**

Many of the first efforts at modelling the mortgage market came in the form of complete housing sector models, of which Smith's (1979) model of the Canadian market is particularly characteristic (and is indeed one of the later formulations of the complete sectoral approach). Smith estimates a stock-flow model using OLS on quarterly data from 1954 to 1965. Three equations are specified to characterise the operation of the housing market. First, housing starts are assumed to depend upon

house prices, total construction costs and the cost and availability of mortgage finance<sup>1</sup>. Second, the specification of house prices is the result of equilibrium between the demand for and supply of housing. Housing demand is assumed to depend upon the usual variables (including real permanent income, demography, house prices and the cost and availability of finance; see Chapter 7 later in the thesis for a discussion) whereas the stock supply of dwellings is a function of its lag and lagged terms in housing starts. Finally, the annual change in construction costs<sup>2</sup> is assumed to be a function of changes in construction sector earnings, the cost of financing, land costs and supply bottlenecks (estimated as being generated by above-trend capacity utilisation).

Moving to the mortgage market, Smith continues the analysis by estimating a disaggregated model of mortgage approvals across different types of mortgage supplier, with the approval process being assumed to be driven by the supply side of the market. The interaction of mortgage supply with demand (the latter being dependent on the determinants of housing demand plus the cost of mortgage finance relative to equity finance) then generates an estimating equation for the mortgage rate.

The major drawback with this type of model has tended to be that it has been characterised by empirically-led functional specifications based on stock and flow considerations rather than on any theoretical model. As such, the preferences of neither mortgage suppliers nor borrowers are modelled from a formal analysis of their optimising behaviour.

In contrast to Smith, O'Herlihy and Spencer (1972) limit the scope of their analysis to the UK building society sector alone and as such are able to undertake a more in-depth analysis. The model attempts to estimate the major flow equations for the building society sector, being specified as gross receipts and withdrawals of shares and

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<sup>1</sup> Kearn and Mishkin (1977) also present a model of housing starts dependent upon the availability of credit.

<sup>2</sup> It is argued that the equation is specified in terms of the annual change in order to alleviate the problem of the variability of the quarterly series.



deposits<sup>3</sup>, new mortgage advances and mortgage repayments, in addition to the rates of interest on shares and deposits and mortgages. The system of equations is estimated over the period 1955 to 1970 using two-stage least squares. Of particular interest is the equation for new mortgage advances, which accounts for the presence of non-price rationing in the mortgage market by including two dummy variables which indicate the presence of either mild or strict rationing (constructed on the basis of anecdotal evidence). The coefficients on the dummy variables are found to be highly significant, with the coefficient on the strict rationing dummy being greater than that on the mild dummy, as expected. The inclusion of proxies for mortgage rationing in the function for new advances allowed its interpretation as a what O'Herlihy and Spencer term a 'modified demand equation'. However, the treatment of rationing in this way, despite being innovative at the time, has been the subject of intense criticism. As noted by Hendry and Anderson (1977), the dummies are really endogenous and are not an explanation of rationing (although O'Herlihy and Spencer do accept this problem in their paper). A further criticism of the construction of the dummy variables is that they imply constant magnitude effects of rationing (i.e. they do not reflect a continuous degree of rationing, but only 'mild' or 'strict')<sup>4</sup>.

These early stock and flow models of the mortgage market eventually were replaced by more elaborate optimisation models of mortgage supply. Of this type of model, perhaps the most widely used as a theoretical basis for empirical investigation in the history of mortgage market literature has been that of Hendry and Anderson (1977), more recently revised by Anderson and Hendry (1984). The broad appeal of this theoretical model comes from its ability to support a variety of empirical specifications; as such, the model deserves special attention here.

Anderson and Hendry assume that the building society's objective is to choose planned mortgage supply and rates of mortgage and deposit interest in order to minimise a logarithmic quadratic cost function. Disutility in the cost function is

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<sup>3</sup> These are specified individually rather than as a net series, since it is argued that the decision to withdraw funds is likely to be made by a different group of individuals than those deciding to invest additional funds.

<sup>4</sup> Sharpe (1973) specifies a similar model to that of O'Herlihy and Spencer (in terms of general structure) although no account of rationing is made.



assumed to be generated by unsatisfied mortgage demand, adjustment costs from altering the mortgage and deposit rates and the quantity of mortgages traded, deviations of the actual reserve ratio from its desired level, and deviations of the mortgage rate from its (unobservable) target rate. These conflicting objectives are included to account for the fact that building societies are not driven solely by the objective of maximising profits. As we will see later in Chapter 5, the literature on credit unions in the US provides some insight into the selection of an objective function for UK mutual institutions.

The cost function is minimised with respect to current and capital account identities (the link between the two being that the after-tax surplus generated on the current account is added to reserves on the capital account each period) and behavioural equations for societies' real demand for shares and deposits and for real personal sector mortgage demand<sup>5</sup>. The minimisation provides Anderson and Hendry with a basis for the parameterisation of dynamic and static equations for mortgage and deposit interest rates and supply-driven mortgage and deposit quantities; the former two are the most interesting and are thus considered briefly below. The theory suggests that the mortgage interest rate should be a mark-up over the deposit interest rate and should also depend on the determinants of mortgage demand; estimation using UK building society data over the period 1958 to 1980 confirm that this is indeed the case, with the coefficient on the deposit rate in the mortgage rate equation being positive at 0.70 and highly significant (with a *t*-statistic of 14.0).

The importance of the deposit rate equation cannot be understated since it essentially drives the entire model. This, however, is the weak link in Anderson and Hendry's empirical analysis. Difficulties in modelling empirically the deposit rate arise mainly from the complexity of the theoretical formulation, the existence of the unobservable target mortgage rate in the equation and industry-specific characteristics which cannot be modelled theoretically or empirically. Nevertheless, the deposit rate was found to

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<sup>5</sup> *Static* equilibrium solutions are derived by assuming that the reserve ratio, liquid asset ratio and mortgage to deposit ratio are constant and that the change in reserves is zero. However, it is the minimisation of the cost function discussed in the text which is of interest, since this represents the full *dynamic* model specification in which long run outcomes are not necessarily achieved. As such, one may consider the model to be one of disequilibrium.

depend positively on competing interest rates and excess mortgage demand, and negatively on the liquidity ratio. The deposit rate equation was the only function for which parameter constancy was rejected.

As previously mentioned, a number of studies have made use of Anderson and Hendry's framework. Hewitt and Thom (1978), for example, apply the methodology of Hendry and Anderson (1977) to model empirically the gross flow of building societies' new mortgage advances in Northern Ireland<sup>6</sup>. The province is assumed small enough to allow societies' interest rates and mortgage rationing behaviour to be considered as exogenously imposed by their UK counterparts; as such, mortgage demand is identified by the inclusion of exogenous terms in the mortgage equation to account for the extent of mortgage rationing. Although no dynamic model is estimated, results from the static equilibrium model indicate that the elasticities of mortgage advances with respect to income and the mortgage rate are lower than those reported in Hendry and Anderson. Hewitt and Thom also use the model to calculate estimates of excess mortgage demand, finding that in 27 of the 31 quarters up to 1973 Q4 excess demand was non-negative.

However, a more rigorous and general approach to the direct estimation of mortgage demand is provided by Meen (1990b). A similar cost function to that proposed in Anderson and Hendry (1984) is minimised yielding an equivalent dynamic flow equation for mortgages; mortgage flow *demand* forms a component part of this equation, and for estimation purposes is assumed to depend upon house prices, the after-tax mortgage rate, household income and the previous period's stock of outstanding mortgages. The coefficient on the mortgage rate in the mortgage equation is around the same level of that reported in Anderson and Hendry (although two further lags of the variable are included in Meen's specification).

Additionally, Meen reports estimates of excess mortgage demand, showing that the gap between demand and supply declined from its peak of around 5 per cent in 1967 to under zero in the early to mid-1980s, following which it rose in the late 1980s as

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<sup>6</sup> A standard partial adjustment model is used to model shares and deposits.



the demand for housing boomed. Meen shows that the quantity of mortgages traded during the period 1980-1988 was primarily demand determined, unlike that of the period prior to 1980.

Using a sectoral model of the building society industry, Wilcox (1985) also examines the extent to which rationing persisted in the UK mortgage market during the period up to the early 1980s. In this Bank of England discussion paper, building societies are modelled as choosing their rates of interest on shares and deposits and mortgages and the loan to value ratio according to three equations. Each function is, in the long run, assumed to be dependent upon the stock of liquid assets, whereas in the short run liquid assets are considered a residual term resulting from the selection of interest rates and loan to value ratio. Two structural equations of the demand for shares and deposits and for mortgages are also specified; the former is assumed to depend on competing and own rates of interest following a standard portfolio approach to asset allocation, whereas the arguments of the latter result from the household's utility maximisation process subject to budget and rationing constraints<sup>7</sup>. The five equations are estimated both in their short run dynamic and long run equilibrium forms. The deposit and mortgage equations were both found to be characterised by slow adjustment to equilibrium following a change in the exogenous variables. Wilcox estimates unrationed mortgage demand by assuming that the *highest* loan to value ratio over the estimation period represented a situation of no rationing. However, this methodology is somewhat flawed since any estimates of excess demand over the period will *always* be non-negative. His conclusion that, "although the building societies moved towards market clearing in the 1980s there was still some rationing in 1983" must therefore be interpreted with particular care. A more objective methodology for estimating excess mortgage demand is presented in Chapter 7 of this thesis.

More recently, Paisley (1994) develops a one period theoretical model of building society mortgage and deposit rate setting, with demand functions for mortgages and deposits specified as semi-log linear functions of their respective own interest rates

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<sup>7</sup> No theoretical model is presented in the paper.



among other variables (equilibrium in each market being demand driven). The interesting feature of Paisley's model is that the assumption is made that societies set their rates in order to maximise profit, which contrasts with much of the US credit union literature (see Chapter 5 for a review) and with other models of the UK building society industry, such as Anderson and Hendry (1984)<sup>8</sup>. Optimisation is subject to balance sheet and income restrictions in addition to a constraint specifying liquid assets as a function of deposits. The optimal deposit rate is found to depend upon a weighted average of the (exogenous) rates on liquid assets and wholesale deposits, in addition to the elasticity of deposit demand to the deposit rate; as in Anderson and Hendry (1984), the mortgage rate then turns out to be a mark-up over the deposit rate. Cointegrating and error correction estimations of the model on post-1984 monthly data were found to perform well, passing both predictive failure and stability tests<sup>9</sup>. However, as Paisley notes, the model lacks any consideration of risk and could certainly benefit from an extension to more than one period.

Not all mortgage market models have been developed as the result of the building society optimisation process. Smyth and Arora (1989) formulate a straightforward (yet appealing) dynamic model of the mortgage market which relies on simple demand and supply equilibrium rather than any form of maximisation. Demand and supply functions are specified as partial adjustment equations dependent upon the mortgage rate of interest and vectors of exogenous variables. The results of interest are obtained from the derivation of equilibrium equations for mortgages traded and the mortgage rate of interest. In the equilibrium mortgage equation, the vectors of exogenous demand and supply variables appear only in *current* terms; as such, the quantity of mortgages traded is found to converge monotonically to equilibrium following a demand or supply shock. However, in the equilibrium interest rate solution, the vectors appear in their *lagged* form, which can lead to the interest rate overshooting in response to an exogenous shock<sup>10</sup>. The model is estimated by Smyth and Arora on

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<sup>8</sup> However, Paisley shows that the maximisation of societies' profits in her model is equivalent to the maximisation of the size of their balance sheet when subject to a minimum capital constraint.

<sup>9</sup> Lagged changes of the exogenous rates were included in the ECMs in order to account for the delayed response of building societies to changes in official rates (see Suddards (1983) for a discussion of the insensitivity of building society mortgage rates to market conditions).

<sup>10</sup> Whether or not the mortgage rate overshoots is shown to depend upon the relative size of the adjustment parameters in the demand and supply functions.



US data from 1973 to 1983 using a full-information maximum likelihood technique. They find the mortgage demand curve to be more inelastic than the supply curve, which is shown to lead to a speedy adjustment in the quantity of mortgages traded following an exogenous shock to demand or supply. Simulations using the estimated equations also confirm the overshooting effect of the mortgage rate of interest.

Drake and Holmes (1997) estimate a relatively straightforward model of mortgage demand and supply incorporating the assumption that building societies face an adverse selection problem. High mortgage rates are supposed to 'screen out' low-risk borrowers leaving mortgage lenders with a larger proportion of higher risk borrowers in their asset portfolio. Raising the mortgage rate may then have the effect of reducing profits as the probability of (costly) arrears and possessions rises, and a backward bending mortgage supply curve results. This is accounted for in the mortgage supply function by including not only the mortgage rate ( $r_m$ ) but also its square ( $r_m^2$ ); adverse selection is then confirmed if the coefficient on  $r_m$  is positive and that on  $r_m^2$  is negative. This is indeed found to be the case when the model is estimated on quarterly building society data over the period 1980 to 1992<sup>11</sup>, with the turning point being calculated at 11.86 per cent<sup>12</sup>. The long run demand and supply functions for net advances are estimated using Johansen's (1988) methodology on the assumption that a combination of the loan to value ratio (as a proxy for non-interest rate mortgage terms) and the mortgage interest rate clear the market in each period. It is found that the loan to value ratio exerts a greater influence on mortgage demand than does the mortgage rate, a result confirmed in other studies including Nellis and Thom (1983) and Wilcox (1985). The mortgage rate, however, is by far the most important influence in the supply equation. Error correction models are estimated using three-stage least squares where it is found that the adjustment to long run equilibrium is reasonably slow: only 18 per cent of the adjustment in supply and 16 per cent in demand occurs during each period.

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<sup>11</sup> One assumes that the mortgage lending data has been break-adjusted to take account of the effect of the conversion of the Abbey National building society to bank status in July 1989.

<sup>12</sup> Drake and Holmes provide supportive anecdotal evidence for this theory, stating that the large increase in arrears and possessions during the early 1990s followed a sustained rise in the mortgage rate above the 'optimal' rate of 11.86 per cent.



There are, however, a number of criticisms of the model. Firstly, the empirical specification of the structural equations is based on casual empiricism rather than any theoretical model. Secondly, no account is taken of the structural changes in the mortgage market occurring during the period of estimation. Further criticism of the paper appears later in the thesis in Chapter 6.

Explicit disequilibrium models of the mortgage market have been sparse in the literature, although three from the late 1980s are discussed here<sup>13</sup>. Askari (1986) specifies a partial adjustment model in which the demand for and supply of mortgage approvals are a function of the difference between the current period's desired mortgage stock and the previous period's actual stock<sup>14</sup>. The disequilibrium nature of the model implies that the mortgage rate adjusts too slowly to bring about market equilibrium, and as such Askari specifies two alternative processes for mortgage rate adjustment. The first allows for the mortgage rate to adjust at different speeds depending on whether the market is characterised by excess demand or supply, whereas the second assumes the adjustment is symmetrical<sup>15</sup>. In both cases, the quantity of mortgages traded is assumed to be the minimum of demand and supply. The model is estimated on Canadian data over the 20 year period to 1976 using maximum likelihood and it is found that, according to a likelihood ratio test, both disequilibrium specifications perform considerably better than the equilibrium version. In the first disequilibrium model, the mortgage rate is found to adjust upward more speedily in response to excess demand than downward to excess supply, which is understandable if the objective of mortgage lenders is to maximise profits. In all models, income elasticity of demand of greater than unity indicates the importance of income in the mortgage approval process<sup>16</sup>. In addition, higher interest elasticities for

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<sup>13</sup> Other disequilibrium models of the mortgage market include Smith and Brainard (1982) and Browne (1988).

<sup>14</sup> Desired mortgage demand is assumed to depend on the mortgage rate, real personal disposable income, the real house price and expected inflation; desired supply is a function of the mortgage rate, the return on alternative investments and the total available funds of societies.

<sup>15</sup> The first model is seen as more restrictive since the sample must be separated into excess demand and supply regimes prior to estimation. Askari performs this according to directional changes in the mortgage rate, finding that the majority of the period was characterised by excess mortgage demand.

<sup>16</sup> Studies that have specifically investigated the significance of income in determining housing demand (and thus also mortgage demand) include Goodman and Kawai (1982), Cameron (1986), Goodman (1988), Haurin and Gill (1987) and Haurin (1991), the latter two concentrating particularly on the effects of income variability.



supply than demand possibly underline the availability of more investment opportunities for mortgage lenders than borrowing opportunities for house purchasers. Based on the second disequilibrium model, it was found that for the majority of the sample period the Canadian market was characterised by excess mortgage supply (in contrast to the findings of both the simplistic separation undertaken in the first model and other models of the Canadian market).

Hall and Urwin (1989) undertake a similar disequilibrium model of the mortgage market to that of Askari (1986) albeit with a number of important changes. As in Wilcox (1985), mortgage demand is derived from housing demand which in turn results from a standard (but unspecified) household utility optimisation problem. On the other hand, the supply of funds to finance mortgage supply is divided into the supply of personal sector shares and deposits (which depends on own and competing asset returns) and that resulting from "societies' behaviour" (i.e. taking into consideration wholesale funding, legal liquid asset ratios and assuming that the loan to value ratio is indicative of societies' willingness to lend mortgage funds). Both equations include a lagged dependent variable to account for the slow dynamic adjustment to equilibrium. The interest rate adjustment equation is specified as the change in the ratio of the societies' deposit rate relative to a competing rate and is assumed to depend on the extent of excess mortgage demand and a lagged dependent variable. The model is estimated over the period 1969 to 1986 explicitly allowing for structural breaks caused by changes to the institutional structure of the market. The estimated interest rate equation suggests incredibly slow adjustment towards equilibrium (confirming the use of a disequilibrium rather than market clearing model), although estimates of excess mortgage demand (reaching a maximum of 4 per cent of mortgage lending) are less than those reported in Wilcox's paper. All of the signs of the coefficients in the long run mortgage demand and supply equations are as expected, and parameter stability is tested for and confirmed. However, an unreasonably high coefficient on the number of owner occupied houses in the demand model is attributed to either insufficient data or the variable picking up a trend in mortgage demand. A particularly interesting finding of Hall and Urwin's model is that during periods in which banks' mortgage market share rose, rationing fell as

societies were forced to become more competitive to retain their position. This confirms the anecdotal evidence observed in the mortgage market during these periods.

Finally, Goodwin's (1986) disequilibrium model of the US housing and mortgage markets has followed a different approach by allowing for disequilibrium quantity rationing<sup>17</sup> in either market to spill over into the other. Notional demand and supply functions are specified for housing and mortgages which are assumed to be dependent upon vectors of exogenous variables and a single lag of the dependent variable. Asymmetric spillover effects are then generated through the effective demand and supply schedules which are functions not only of their notional counterparts but also of terms representing excess demand and supply in the other market<sup>18</sup>. In order that minimum distance estimators (a variant of three-stage least squares) may be used, the sample is separated into regimes of excess demand and supply using various pieces of information, including the direction of movement of the price terms. The model is estimated on US data over the period 1964 to 1980, the results providing strong evidence to suggest that excess demand in the mortgage market spills over into the housing market. Disequilibrium spillover effects from the housing market to the mortgage market, however, were found to be markedly weaker. The model is limited in that the choice of the set of exogenous variables is largely *ad hoc* and it suffers from the restrictive requirement of the *a priori* sample separation.

It is important to note that whilst a disequilibrium model of the UK mortgage market may have been appropriate prior to the early 1980s, this is clearly unlikely to be the case in the less restrictive mortgage market which has prevailed since then.

One may observe that in comparison to mortgage supply, relatively little has been written on the demand for mortgage finance since it is usually assumed that it is driven by the demand for housing (Jones (1993, 1995) calls this the 'linkage

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<sup>17</sup> By disequilibrium rationing we refer to rationing which is not alleviated by changes in the price vector. Chapter 7 considers this phenomenon in greater depth.

<sup>18</sup> Again, it is assumed that the short side of the market dominates (there is voluntary exchange).



hypothesis')<sup>19</sup>. As we have seen in the papers reviewed above, few present any formal analysis on the demand for mortgage debt. However, given that a surprising percentage of homeowners hold no mortgage debt, it cannot be the case that housing demand is the sole explanation of mortgage demand. Jan Brueckner has devoted considerable time in modelling the demand for mortgage finance; here we briefly review his 1994 paper which presents a basic model of mortgage demand. This paper is similar to that of Jones (1993, 1995), which is considered in more depth in Chapters 6 and 7 later in the thesis. Essentially, the representative household chooses (simultaneously) the value of the house and mortgage loan and the desired level of savings in order to maximise lifetime utility (assumed to be a function of current consumption of housing and other goods and future wealth) subject to a standard intertemporal budget constraint, a restriction on the loan to value ratio and other technical constraints. The results of the theoretical optimisation show that when the after-tax savings rate ( $r$ ) exceeds the after-tax mortgage rate ( $r_m$ ) (as in the US due to the tax deductibility of mortgage interest), the household will take on the largest allowable mortgage (in other words, the loan to value constraint will bind); otherwise, the household could borrow additional mortgage funds to invest at the higher rate,  $r$ , which would add to both future wealth and utility. On the other hand, when  $r_m > r$ , optimal mortgage demand varies only according to the household's degree of time preference<sup>20</sup>. The results for the latter case are unchanged when  $r$  is allowed to be stochastic, but for the former case any level of mortgage becomes possible, consistent with anecdotal evidence from the US which suggests that households desire lower loan to value ratios than originally predicted in the certainty case<sup>21</sup>.

Although Brueckner derives the comparative statics of the certainty model<sup>22</sup> and suggests a possible methodology for estimation, it has been left for future studies to undertake the relevant empirical analysis. It will be seen later in the thesis (Chapters 6

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<sup>19</sup> As part of his utility maximising model of mortgage demand, Jones (1993, 1994, 1995) discusses extensively how the demand for mortgage finance may be dependent upon households' demand for certain non-housing assets, and presents evidence supportive of this conjecture.

<sup>20</sup> Nevertheless, it is shown that in this case, when savings are greater than zero mortgage demand must be zero.

<sup>21</sup> The results for neither case are altered by allowing randomness in either prices or incomes.

<sup>22</sup> It is found that mortgage demand depends non-negatively on the value of the house and future income and non-positively on the household's initial wealth and the discount rate of interest.



and 7) that in a macroeconomic setting there are identification problems in estimating mortgage demand (due in part to the problem of rationing). However, a number of studies have estimated mortgage demand in a microeconomic framework. Follain and Dunskey (1996), for example, base their microeconomic study of mortgage demand on the theoretical results derived by both Brueckner (1994) and Jones (1993, 1995)<sup>23</sup>. In their paper, two models are estimated using the 1983 and 1989 (US) Surveys of Consumer Finances (SCF). Firstly, a reduced form model of mortgage demand is estimated using a tobit estimator to account for the censored nature of the dependent variable<sup>24</sup> (mortgage demand for some households will be zero), the specification including both the difference between the mortgage rate and (a) the after-tax return on savings (reflecting the cost of mortgage funds relative to owner equity) and (b) the after-tax rate on consumer credit<sup>25</sup>. Estimates of the parameter on the first relative cost term were, as expected, negative and highly significant for both SCF samples, and the coefficient on income was significantly positive.

Secondly, a structural model was also estimated in which mortgage demand was assumed to depend (in part) upon housing demand, which in turn was specified separately. Using a simultaneous tobit estimator<sup>26</sup>, the coefficients on the cost difference terms were again correctly signed and significant (yet smaller than their reduced form counterparts)<sup>27</sup>, as were those on after-tax income. The marginal effects for the reduced form model were computed for a variety of subsamples (based on income levels and credit constraints), with the elasticity of demand for mortgage debt with respect to the rate of mortgage interest relief being high at -1.5 for 1983 and -3.5 for 1989, and larger for higher income groups. The results led Follain and Dunskey to conclude that any reduction in mortgage interest relief would have a considerable impact on the demand for mortgage finance (and possibly housing).

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<sup>23</sup> Although Follain and Dunskey allow for further uncertainty in the future utility function, their final specification of lifetime utility is kept relatively simple given the complexities involved in the optimisation procedure.

<sup>24</sup> Ham and Melnik (1987) undertake a microeconomic study of the demand for US commercial loans using a similar modelling strategy.

<sup>25</sup> In addition, a considerable number of household specific variables were included in the estimations.

<sup>26</sup> The use of this estimator was confirmed by the rejection of tests for the exogeneity of housing demand.

<sup>27</sup> The authors suggest that this implies the reduced form coefficient captures a substitution away from debt towards equity *and* a reduction in housing demand following a rise in the cost of debt.

As a brief summary to this section, the literature on the mortgage market has evolved from relatively simple stock-flow type models, typically estimated by OLS or two stage least squares, into elaborate supply and demand specifications based not on casual empiricism but rather on formal optimisation models of the decisions made by participants in the market. In addition, with the advent of cointegrated time series modelling techniques during the 1980s, the estimation and testing of such long run specifications has become more rigorous. Models of this type will be investigated, developed and estimated later in the thesis.

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## **CHAPTER 2**

### **The Changing Nature of the Mortgage Market in the United Kingdom**

#### **2.1 INTRODUCTION**

Any study of building societies and the mortgage market as a whole would be incomplete without addressing the way in which the market operates and how the market has changed, particularly over the past two decades. It will be seen later in Chapter 5 that the changing role played by building societies in the provision of mortgage finance must be taken into consideration when constructing a theoretical model of societies' interest rate setting. In addition, increased competition in the mortgage market, particularly over the last 20 years, has important implications for the empirical modelling of mortgage demand and supply as we will see in Chapter 7.

This chapter provides a qualitative discussion and analysis of the nature of the UK mortgage market, focusing particularly on the changes that have taken place over the past 20 years. Section 2.2 begins by outlining the way in which the housing and mortgage markets interact with the economy as a whole and considers a variety of alternative viewpoints on the issue. The first subsection of Section 2.3 examines briefly the historical evolution of UK mortgage lending institutions in order to provide the background to the second subsection which investigates in detail the developments within the market since 1970. Section 2.4 then considers in more depth the current regulatory environment in which mortgage lenders (and in particular building societies) operate, following which Section 2.5 outlines the recent trend in mergers, acquisitions and conversions from mutual to Plc (bank) status in the building society industry. Finally, Section 2.6 concludes by summarising the salient points of the chapter.



## 2.2 THE IMPORTANCE OF MORTGAGE FINANCE IN THE WIDER ECONOMY

It is argued that the housing and mortgage markets play a crucial role in the wider economy. House building accounts for a significant portion of GDP and thus a boom in the housing market is often associated with a boom in the economy as a whole. An alternative viewpoint expressed has been that construction is a counter-cyclical demand management tool of the government, used to flatten cyclical swings. However, it is the former pro-cyclical view on the interaction of the housing market with the wider economy that has been most prominent over the past two decades (see Hamnett (1994), for example). If this is true, then the recent spate of deregulation in the mortgage finance industry will have had dramatic economy-wide effects. The housing market growth in the late 1980s, for example, played a crucial role in the overall economic boom between 1985 and 1989. Nevertheless, it is important to note that although the provision of mortgage finance to fund such housing market transactions was instrumental to the housing boom of the late 1980s, the ease of attaining such finance should not be seen as a direct cause of house price inflation. Rather, it was the combination of declining interest rates and regulatory reform in the latter half of the 1980s that served to promote competition within the housing finance industry, fuelling the boom in housing and asset prices.

In its simplest form, a strong housing market will stimulate demand for consumer durables and induce other housing related expenditure, having multiplier effects throughout the whole economy. The general mechanism by which housing is pro-cyclical is that as house prices rise, so does consumer spending (an important component of aggregate spending) since consumption depends upon personal wealth of which housing is a large component. In the two and a half years from the first quarter of 1987, nominal house prices grew by almost 70 per cent to reach a peak in the third quarter of 1989<sup>1</sup> (*source* : Housing and Construction Statistics Part 2). In stimulating consumption, increases in the value of housing through house price rises encouraged savings to fall, with the seasonally adjusted savings ratio falling to an

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<sup>1</sup> Nominal house prices then proceeded to fall in the subsequent recession by 12 per cent bottoming out in the second quarter of 1993.

almost 30 year low at 4.9 per cent of disposable income during the peak of the boom in the third quarter of 1988, and rising to almost 13.5 per cent during the depth of recession in the third quarter of 1992 (see Figure 2.10 later in the chapter<sup>2</sup>). In addition, the upswing in property prices led to the withdrawal of equity from the housing market as some households moved to a property of lower value or borrowed against unwithdrawn equity (Holmans (1990) notes that the latter has gained in importance at the expense of the former during the 1980s as consumers have re-mortgaged their houses to benefit from cheaper loans). Carruth and Henley (1990) have estimated the effect of housing market activity on aggregate consumption and saving, finding that the boom in spending and the fall in the savings ratio were stimulated by the potential to withdraw significant amounts of equity from housing. Their study estimates that equity withdrawal may have added up to 4 per cent to consumer spending in 1988.

The argument of the previous paragraph can help explain how the slump in the housing market helped to cause the recession of the early 1990s. As households strived to repay their debt with the onset of recession and new mortgage lending came to a standstill, the ratio of mortgage debt to personal disposable income (which had been increasing steadily over the whole of the 1980s) stabilised at around 3 at the end of 1990 (see Figure 2.1 below). This in part was a result of the fact that base rates had reached 15 per cent in 1990, although mortgage rates were held at a lower level to limit the effect of the high interest rates on mortgagors and also to maintain market share. Given that this strategy required that interest rates paid on deposits also had to be kept low (to maintain interest margins), both retail deposit inflows and mortgage supply were subdued.

The above pro-cyclical argument that the slump in the housing market helped cause the wider economic recession is rejected by the Council of Mortgage Lenders (CML), who argue that mortgage borrowing for consumption reasons has been encouraged through channels other than simply through housing equity withdrawal. These include

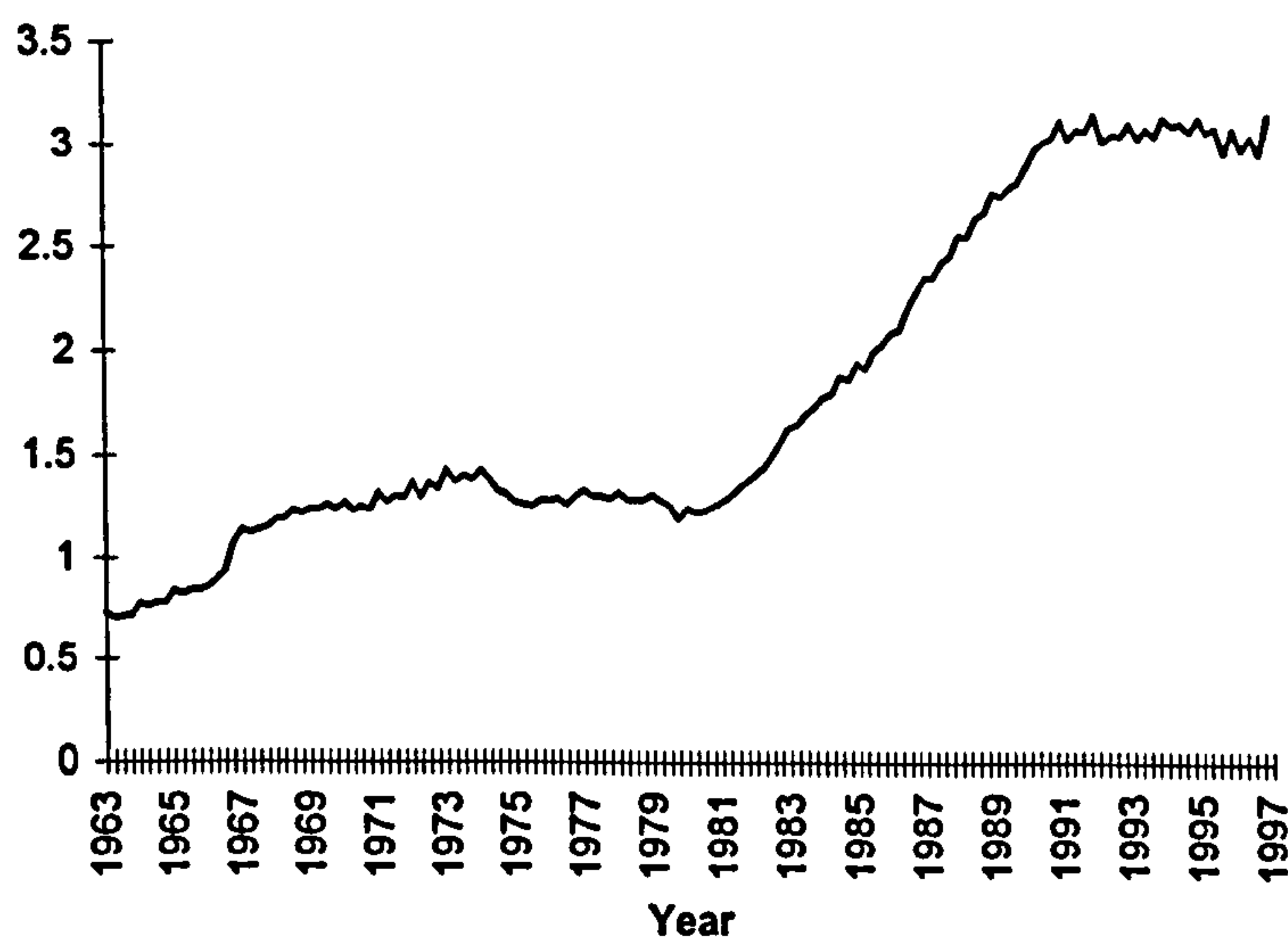
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<sup>2</sup> The savings ratio is also determined by the level of government welfare provision; a lower level of government welfare will encourage households to save more. For example, Japan has a very low level of welfare provision and also a very high savings ratio.



the relatively lax monetary policy of the latter half of the 1980s (base rates fell to 8.17 per cent in the second quarter of 1988, their lowest level since the first quarter of 1978) rapid real income growth, the income tax reductions of the 1988 budget and financial deregulation (which served to make all types of borrowing easier). It is argued by the CML that there exists no causal evidence for the increase in housing wealth being responsible for the consumer boom of the late 1980s. However, Hamnett (1994) perhaps more accurately writes that, “while there is undoubtedly a causal link between the housing market and consumer spending, it is not the only one, nor necessarily the most important”. Nevertheless, the slump in the home ownership market during the early 1990s undoubtedly compounded the economic recession.

**Figure 2.1 : The Ratio of Mortgage Debt to Personal Disposable Income**



*Source : Financial Statistics*

According to the deregulation view, financial market deregulation encouraged greater competition in the mortgage market as new entrants and existing suppliers competed vigorously to accumulate or maintain their market share. In doing so, lenders offered higher loan to value and loan to income ratios, placing less emphasis on the borrower's ability to repay the mortgage loan. As house prices began to fall in the late 1980s and early 1990s, the number of mortgages with negative equity rose dramatically, being followed by considerable increases in the number of possessions



(see Chapter 4 for a theoretical and empirical analysis of arrears and possessions in the housing market).

The boom in housing and consumption came to an end in 1989 and the economy moved towards recession as a result of the combination of rising inflation in retail prices and a tightening of monetary policy (the government's commitment to regulatory reform in the financial services industry left a rise in interest rates as the only option to control personal sector spending and borrowing<sup>3</sup>), the policy being designed to cut back consumer spending and regulate wage and price inflation. In the recession which followed the rise in real housing wealth and mortgage debt during the heady 1980s, individuals were encouraged to build up their savings and reduce their levels of debt and consumption. This cycle was similar to the 'Barber Boom' between 1971 and 1973, during which time average house prices more than doubled; in late 1973, monetary policy was tightened followed by a contraction in the overheated housing market with prices and turnover remaining depressed for some considerable time afterwards.

Government policies have appeared to have been of considerable importance in influencing turnover in the housing market. In fact, as Meltzer (1974) notes, "much 'housing policy' in the US and in Western Europe is 'mortgage policy'", the purpose of which being, "to encourage the production of housing by increasing the 'availability' of mortgage credit". However, it is argued by Meltzer that there is no evidence to suggest that the form of credit provision affects the composition of spending, as it is suggested that the borrower will substitute one type of credit for another rather than one type of asset for another.

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<sup>3</sup> The London clearing banks base rates rose from 8.17 per cent in the second quarter of 1988 to 15 per cent by the first quarter of 1990 (albeit temporarily), an increase of more than 650 basis points within only 7 quarters.

## 2.3 THE UK MORTGAGE MARKET

### 2.3.1 A Brief Historical Overview of the Building Society Movement

Building societies and other friendly societies were originally established in the latter half of the eighteenth century as mutual funds, whose specific purpose it was to finance the housing of fund members. Boléat (1986) points out that such societies grew as a result of the prevailing economic trends and social behaviour, most notably the industrial revolution (as urban immigrants left their rural communities), greater financial sophistication and an increasing appreciation of the Victorian values of thrift self help.

The first building society was established in the Golden Cross Inn in Birmingham in 1775 by Richard Ketley, and by the end of the eighteenth century, the number of societies in the movement had reached between 20 and 50, located mainly in the Midlands, Lancashire and Yorkshire<sup>4</sup> (and, since the Napoleonic Wars, throughout the rest of the country). All of these original institutions were 'true' building societies, known as terminating societies. They existed to provide each member (and no one else) with a house financed from the mutual fund. Their membership at this time was composed in the main of skilled workers, and for any building society typically numbered less than 20. Each member would contribute a regular subscription (usually fortnightly or monthly) to the fund of the society, and construction would begin once sufficient funds had been raised<sup>5</sup>. The order of allocation of housing to members would either be drawn by lots (in which case the right was sometimes sold on) or auctioned to the highest bidder. Whichever way, all members continued to pay subscriptions until each member had been housed, at which point the society 'terminated'. Around 250 terminating building societies had been established by 1825.

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<sup>4</sup> Despite recent changes in the building society movement over the past two decades, it is interesting to note that for the majority of societies their headquarters have remained in these regions.

<sup>5</sup> Each individual held what was known as a 'share' in the society. These funds were then either distributed directly to the members or used to buy houses which were then allocated to the members.



A dramatic increase in building society size and membership during the nineteenth century encouraged terminating societies to evolve into what became known as permanent societies, the first being established in 1845. To speed up the provision of housing finance, permanent building societies accepted deposits (as opposed to shares) from investors who wished to save but not to purchase a house; similarly, the society then had to charge interest to its borrowing members<sup>6</sup>. By the mid-1800s, deposits had become extremely popular. As such, societies were transformed into more flexible financial intermediaries, allowing their activities to continue beyond the time at which their original members had all been housed. Nevertheless, societies retained their objectives of providing housing finance and remained mutual, being run for the benefit of their members and not to maximise profit (any operating surpluses were added to the society's reserves from which occasional bonus distributions were made). An important characteristic of these financial mutuals was that their members could not sell their claims to any operating surplus in a secondary market<sup>7</sup>.

The rapid growth of the building society movement during the early part of the nineteenth century led to the adoption of legislation which specifically targeted societies. The first legal recognition of societies came in the form of the Regulation of Benefit Building Societies Act in 1836, which exempted societies from certain stamp duties and established a 'certifying barrister' (later known as the 'Chief Registrar of Friendly Societies') to formulate the rules of operation and to give advice.

During the 1850s and 1860s, however, the government began to question building societies' exemption from stamp duty. The failure of societies to act as a single movement in lobbying the government over this matter prompted the establishment in 1869 of the Building Societies Gazette, a body set up primarily to promote the interests of the building society industry in the hope of influencing government policy.

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<sup>6</sup> Unlike in terminating societies, borrowing and saving members of permanent institutions were no longer one and the same. Investors were permitted to join at any time without having to make back payments and could withdraw their money on demand, whereas borrowers received a loan to be repaid with interest over a pre-specified duration.

<sup>7</sup> This remains true today. It is also useful to note that the major difference between building societies in the UK and savings and loans (S&Ls) institutions in the US is that where the former can only take the form of mutuality, S&Ls can either be mutual or of stock ownership. In addition, where building societies operate on a 'one-member one-vote' principle, S&L members receive one vote per \$100 invested (up to a maximum of 50 votes).



Additionally, in the same year, the Building Societies Protection Association was founded (the predecessor of the Building Societies Association), another group whose purpose it was to represent the views of mortgage financiers.

Following two years of deliberation, in 1872 the findings of a Royal Commission on Friendly Societies were reported, which included a new role for the Chief Registrar and the recommendation that additional powers be made available to societies. The Report resulted in the passing of the first comprehensive Building Societies Act in 1874, the main provisions of which were to authorise permanent societies to accept deposits up to a total of two thirds of the sum secured by mortgages (or up to 12 months' share subscriptions for terminating societies, whichever was the most beneficial to the society), to grant them corporate status (limited liability) and to restrict the investment of surplus funds only to mortgages or government guaranteed securities (preventing societies from owning other companies, land or buildings other than their own premises to conduct society business). The proposals of the Royal Commission regarding the strengthened powers of the Chief Registrar were also adopted by the Act.

However, the effectiveness of this early building regulatory legislation was restricted by the frailty of the economic environment at the time. The last 25 years of the nineteenth century was a tumultuous period for all financial institutions, with building societies being no exception. Given the economic depression and falling house prices, mortgage financing of property became more risky (the situation was remarkably similar to that of the late 1980s/early 1990s). A number of societies failed as a result of distressed lending and fraudulent activities; in early 1892, the Portsea Island Building Society collapsed (due to the embezzlement of funds which resulted from inadequate supervision) followed later in the year by the failure of the Liberator Building Society (then the country's largest building society) as a result of its speculative investment of funds (with insufficient mortgage demand to absorb higher deposit inflows at the time, societies' investments had become increasingly risky). A new Act in 1894, designed to regain public confidence in the industry, further strengthened the powers of the Chief Registrar by allowing more active intervention



and required societies to disclose their full accounts and conduct more in-depth audits. What were considered to be risky transactions, such as the provision of mortgage finance for a property already mortgaged by another party and the random balloting for mortgages, were also outlawed for new societies<sup>8</sup>. The events of the last decade of the nineteenth century not only encouraged further legislation to be enacted but also fostered a new culture of prudence amongst societies and a subsequent increase in their liquidity ratios<sup>9</sup>.

Despite the collapse of the Birkbeck Building Society in 1911 (again the country's largest society at the time) due to managerial failures and a slump in the price of its stock of gilt holdings, confidence in the building society movement was slowly nurtured back to health during the early years of the twentieth century. The inter-war period was a period of strong growth in the industry, interrupted only by the great depression of the 1930s. Growth was boosted by rising real income, low house prices (ironically as a result of the depression), low interest rates and strict rent controls, all of which discouraged the building of housing for rent and stimulated the demand for owner occupation. The resulting increased demand for mortgages was easily accommodated, as a combination of rising real income and a higher savings ratio encouraged significant retail inflows. Permanent and large localised societies enjoyed the most significant growth as they looked to gain market share outside of their traditional locations<sup>10</sup>. With permanent societies gaining at the expense of terminating societies, the industry naturally became more concentrated and the number of societies fell from its peak of 3642 in 1895 to only 960 at the end of 1939 (*source* : Bol  at (1986)). Whereas terminating societies represented over 50 per cent of all societies at the turn of the twentieth century, by 1932 there were only 16 per cent remaining. In

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<sup>8</sup> Prior to the 1894 Act, there existed what were termed Starr-Bowkett Societies, which were terminating societies providing interest free advances to members. When the society had accumulated a specific sum, this was allotted by ballot to one of the members who was required to repay it by instalments over an agreed term while maintaining his share subscriptions. The new owner of the property could in fact then sell it at a profit which, according to Bellman (1927) was, "a prolific source of discontent amongst other members who were unsuccessful in the ballot". This was eventually abandoned by many societies through the requirement that all profits made on the sale of the property be paid into the common fund of the society (a scheme known as 'alternate ballot and sale').

<sup>9</sup> By 1918, societies' liquid assets represented around 20 per cent of their total assets.

<sup>10</sup> The fact that the majority of societies at this point in time were based in the North meant that there was excess mortgage supply in the North and excess demand in the South. This led to the wider geographic spread of societies throughout the country during the inter-war period.



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fact no terminating society has been established since 1953, and the last one was wound up in 1980. Nevertheless, the take-over of small societies by larger mutual institutions did play an important part in the consolidation of the industry<sup>11</sup>.

The interwar years, despite being a period of considerable growth in the building society industry, did pose a number of challenges. Competition for mortgage business was intense given the low risk and high profitability; attempts to introduce a code of operating ethics to govern the increasingly aggressive business of mortgage lending divided the Building Societies Association into two separate bodies. Another problem was that of 'builders' pools', which came to a head with the 1938 'Borders case', generating unfavourable publicity for societies and culminating in the Building Societies Act of 1939. Builders keen to sell houses deposited an amount of money with a society equivalent to the excess of the loan above the society's desired loan to value ratio (usually around 15 per cent of their value) on which the society could draw under circumstances of borrower default. This allowed societies to lend more than the average 75 per cent loan to value ratio by accepting this form of security from the builders. However, as poorer quality housing was constructed for sale to lower income households during the 1930s, societies found themselves lending mortgage funds on the basis of unsatisfactory security; with the borrower's equity in the property being small, problems arose when mortgage repayments could not be met and the value of the house no longer covered the amount of the mortgage outstanding. This led to the case of Mrs Elsie Borders who won her case against the Bradford 3rd Equitable building society, alleging it had lent money for the purchase of a property of unacceptably low quality. As a result of the case, the 1939 Act legislated to define in detail the characteristics of a property deemed acceptable as security on the loan, ending the operation of the builders' pool and leading to the re-unification of the Building Societies Association in 1940.

Mortgage demand subsided in the immediate post-war years as the new Labour government focused its housing policy on building rentable accommodation. This led societies to allow their liquid asset ratios to soar, peaking at 29 per cent (*source :*

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<sup>11</sup> Mergers are discussed more fully later in the chapter with regard to the provisions of the 1986 and 1997 Building Society Acts.



Phillips (1983)). However, the housing market regained buoyancy as the policies of the new 1951 Conservative government (which had the effect of lowering the relative cost of owner occupation and encouraged the expansion of building societies) and loose monetary policy led to a rapid increase in owner-occupier property construction. As such, the volume of mortgage lending recovered during the 1950s and liquidity ratios were restored.

The importance of building societies in the provision of housing finance was recognised by the House Purchase and Housing Act of 1959, under which the government lent the societies £100 million (£1.2bn at 1996 prices) for mortgage lending to purchasers of pre-1919 houses. The only event to mar the expansion in the market was the collapse of the State Building Society in 1959, following substantial unsecuritised lending to a property company which used the monies to leverage a series of take-over bids. The extent of prudential supervision in the mortgage market was closely scrutinised, not only as a result of this collapse but also due to the liquidity crisis experienced by Scottish Amicable, then one of the country's largest mortgage lenders.

These events led to the passing of a new Building Societies Act in 1960, which authorised the Chief Registrar to require societies to hold certain liquid assets in order that cash flow considerations should not be compromised. In addition, societies were limited in their ability to undertake corporate loans, being required to make at least 90 per cent of advances on owner occupied housing. This Act, which was essentially designed to curb the activities of suspect societies, and all previous legislation was consolidated in the Building Societies Act of 1962. In addition, the 1962 Act set out the rules under which societies were authorised to take part in intra-sector mergers and acquisitions. Two types of merger were defined: transfers of engagements (akin to acquisitions in the publicly owned sector, usually where a smaller society is acquired by larger society) and unions (or mergers in the publicly owned sector, where the parties are of equivalent size<sup>12</sup>).

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<sup>12</sup> Unions have since been renamed 'mergers and amalgamations' by the 1986 Building Societies Act. The collective terms as defined here are used interchangeably throughout the thesis.

Consolidation in the building society industry continued throughout the 1960s and 1970s; as the number of building societies dwindled, the importance of the industry rose considerably (society assets rose by more than threefold during the 1960s alone) as owner occupation became increasingly popular (again aided by government policy). Deposit accounts lost out to share accounts due to the higher rates of interest offered on the latter. However, it was the rate of interest charged on mortgages that became the primary political focus of the 1960s, and in 1966 building societies' interest rate setting procedure was referred to the Prices and Incomes Board. The main recommendation of the Board, however, did not address the level of mortgage interest rates; rather, the Board suggested that the Building Societies Association establish a committee to advise on reserve and liquidity requirements. The result of this was the establishment of a minimum reserve ratio which declined as total assets of the society increased (i.e. smaller societies were required to keep relatively higher levels of reserves than larger societies), despite the existence of a *constant* minimum liquidity ratio across all societies.

The political pressure on building societies was heightened further during the 1970s as the government laid the blame on the industry for the rapid rise in house prices during the early part of the decade<sup>13</sup>. During the 1970s building society business boomed, as reflected in the increase in the total number of branches from 2000 to 5700 over the decade, and share accounts from 10 million to 30 million over the same period (*source* : Phillips (1983)). A possible reason for the boom in mortgage business could have been the substantial fall in the real mortgage rate during the latter half of the decade as nominal rates failed to keep up with spiralling inflation.

From this brief history of the building society movement, it is clear that the evolution and development of mortgage lending institutions since the eighteenth century has been shaped not only by the requirements of their owner occupier customers but also by the nature of the regulatory legislation which in turn has often been enacted in response to financial crises in the industry. We will see in the following subsection and in Section 2.4 how the regulation of the mortgage market has affected the

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<sup>13</sup> Building society relations with the government were improved substantially, however, after the establishment of the Joint Advisory Committee in 1973.



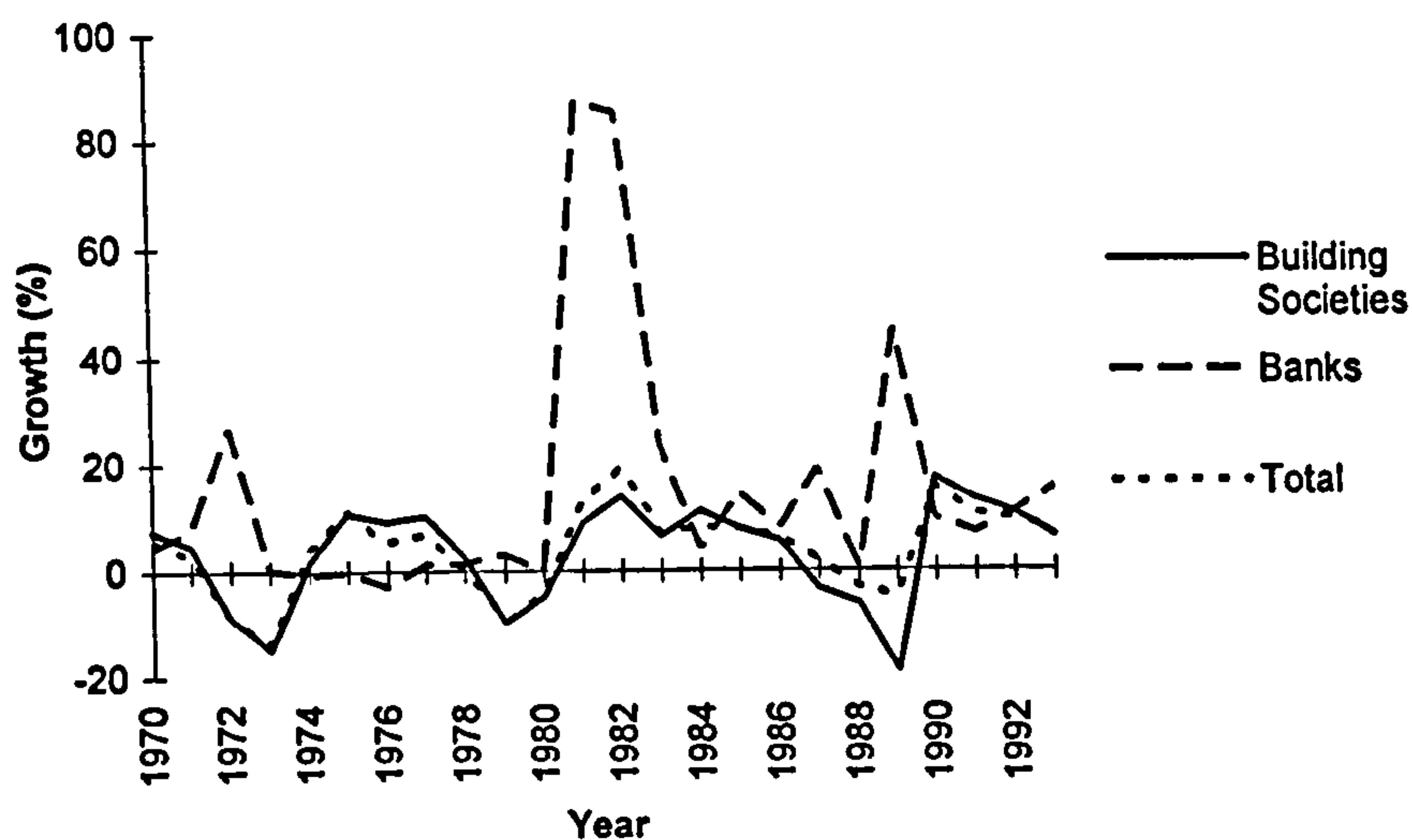
continued expansion of building societies' business and indeed mortgage provision in general during the 1980s and 1990s, encouraging the demise of mutual institutions and the emergence of new and larger publicly owned financial conglomerates.

### **2.3.2 A General Synopsis of the Mortgage Market Since 1970**

Over the last twenty five years there has been a dramatic change in the behaviour of UK building societies. The range and scope of services offered by societies has increased to the point that they are now very close substitutes for the clearing banks in many areas. In fact it has been during the 1980s and 1990s in which the most profound changes have occurred with intensification of competition in both the mortgage and deposit markets. The increase in importance of building society activities was recognised by the Bank of England through the creation in May 1987 of a new monetary aggregate (M4) which included private sector holdings of building society shares and deposits. In June 1988 the stock of £M3 was £202bn and the stock of M4 £329bn (*source* : Hall and Urwin (1989)), almost all of the difference of £127bn being accounted for by building societies. However, since 1989 the change within the mortgage finance industry has manifested itself in the de-mutualisation of a significant proportion (in terms of the value of mortgage lending) of building societies. This development is discussed later in the chapter in Section 2.4 and more specifically in Section 2.5.

The growth in real mortgage lending strengthened substantially in the 1980s compared with both of the previous two decades (see Figure 2.2 below), this period of growth coinciding with major changes in the institutional structure of the UK mortgage market. Such changes were quite unprecedented and amounted to a relaxation of the constraints under which all participants in the mortgage market operated.

**Figure 2.2 : Growth in Real Mortgage Lending by Banks and Building Societies<sup>14</sup>**



*Source : Financial Statistics*

During the 1970s, the mortgage market was essentially dominated by building societies which were virtually the only source of mortgage supply. They accounted for an average of 78 per cent of the stock of mortgage lending during the 1970s, and in the second quarter of 1979 (when the proportion of mortgage lending undertaken by building societies was at its height) the share of mortgages was 82.3 per cent for building societies, 7.6 per cent for local authorities, 4.7 per cent for banks, 3.9 per cent for insurance companies and pension funds, 1.3 per cent for central government and 0.2 per cent for public corporations (*source : Financial Statistics*). At this time (and prior to the 1986 Building Societies Act) regulation of building societies was based on the 1962 Building Societies Act (see Section 2.3.1 above for a discussion). Because this represented a consolidation of all previous regulation, the Act was essentially based on obsolete nineteenth century legislation and practices. As we have seen, the main provision of the Act was to restrict building societies to use retail funds to finance personal property loans, with their remaining investments being either specific fixed or liquid assets. This proved to be of little consequence to societies during the 1970s and before as a result of their monopolisation of mortgage lending and the lack

<sup>14</sup> The exaggerated peaks in both Figure 2.2 and Figure 2.3 in 1989 were caused by the conversion of Abbey National from being a building society to a bank.



of competition in the market for long maturity retail deposits<sup>15</sup>. In fact, despite the current intensity of competition between building societies and banks, the market for savings remains fragmented to a certain degree, as societies still concentrate on larger and longer term deposits. The way in which this segmentation is achieved is discussed by Smith (1996c) who writes that, "any financial organisation in retail savings can feature in 'best buy' tables by launching a particularly competitive product while continuing to offer less attractive rates across a range of other accounts". However, one cannot deny that the concentration of building societies on the longer term end of the market has generally increased their average cost of funds.

Prior to the 1980s, competition for funds in the retail deposit market was most intense amongst building societies themselves as banks chose to fund primarily in the wholesale markets; as such, banks were relatively uncompetitive in the retail deposit market. However, despite the absence of any strong external competition in their deposit market, building societies were themselves uncompetitive during times of rising interest rates (causing vast outflows of retail funds) as a result of the procedure of infrequent rate changes adopted by the Building Societies Association (BSA). After such an experience in 1973-74, building societies were prompted to introduce new types of retail deposit, such as higher-rate term deposits. Such accounts became very popular and, at the expense of increasing their average cost of funds, societies began to take an increasing share of personal sector wealth during the latter half of the 1970s<sup>16</sup>.

There were two main reasons for the lack of any serious competition from banks and the domination of building societies in the retail deposit market during the 1970s. Firstly, bank lending was restricted by a regulatory device known as the 'Corset'<sup>17</sup> and

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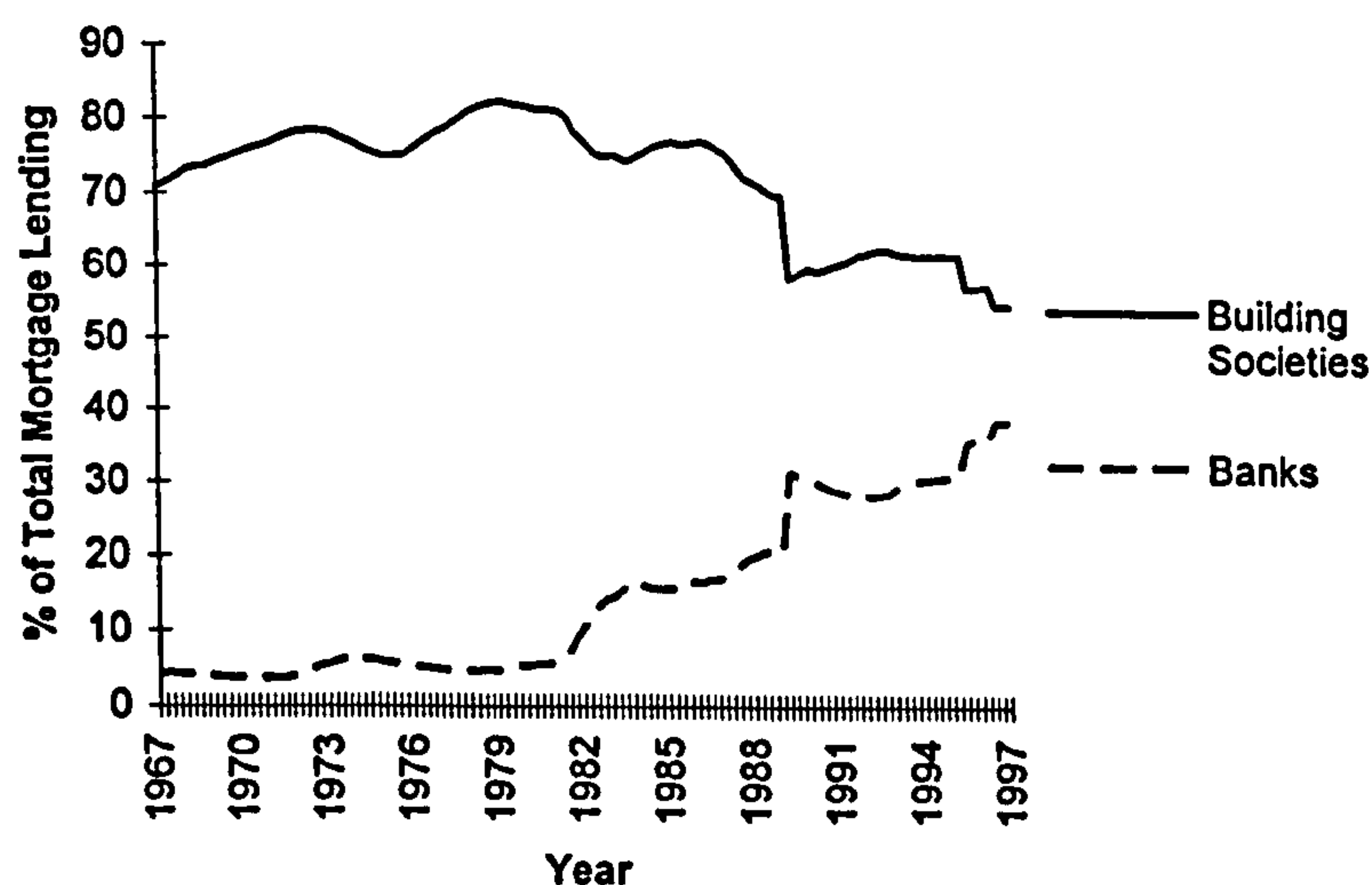
<sup>15</sup> Building societies concentrated on attracting long term savers by offering high interest rates on term accounts while banks focused on the shorter end of the market, offering low (or zero) interest current accounts.

<sup>16</sup> However, in 1979/80 the spread of building society deposit rates over bank rates narrowed briefly and the declining market share of bank deposits was temporarily arrested.

<sup>17</sup> The Corset was the colloquial name for the Supplementary Special Deposits (SSD) scheme which began operation in 1973. It was a direct method of monetary control whereby the Bank of England could require an interest free reserve to be deposited by commercial banks if their interest bearing liabilities rose above specified levels. As such, banks were constrained from lending significant amounts in the mortgage market for the majority of the 1970s.

as such, banks were faced with a paucity of profitable lending outlets. Figure 2.3 below illustrates how building societies have traditionally dominated the market for mortgage finance (although more recently the conversion of building societies to Plc status and the entrance of banks into the market has caused societies to lose a significant proportion of their market share). With banks already commanding a significant portion of personal sector liquid assets and having unlimited access to the wholesale deposit market, chasing additional and more expensive retail deposits would have been futile. Secondly, it was alleged that by competing more vigorously with building societies for retail deposits, banks could have faced an internal migration of funds away from their interest-free current account base (rather than new inflows), serving only to increase the average cost of funds.

**Figure 2.3 : The Changing Market Share of Mortgage Lending between Banks and Building Societies**



*Source : Financial Statistics*

During the period prior to 1980, building societies could be viewed unambiguously as non-profit making institutions. Being mutual institutions with Friendly Society status they attempted to reconcile the conflicting demands between borrowers for low rates and savers for high rates by maintaining a relatively stable intertemporal interest rate



path<sup>18</sup> (the issue of the so-called 'borrower-saver conflict' is addressed in Section 5.2.2 of Chapter 5). This stability was made possible by a cartel arrangement under which the BSA recommended to its members appropriate saving and borrowing rates of interest on a monthly basis. With the primary remit of the BSA cartel being to maintain low borrowing rates in order to protect existing mortgage borrowers, during periods of rising general market interest rates societies' savings and mortgage rates tended to be relatively sticky<sup>19</sup>. The result was that the competitiveness of societies' shares and deposits waned (leading to weaker retail inflows) whilst mortgage demand rose considerably (the former trend is clearly visible in Figure 2.4 below).

The initial response by building societies to this relative lack of available loanable funds tended to be to allow the liquid assets ratio to take up the slack; however, a policy of falling liquidity could not be sustained indefinitely and as such, periods of sustained fund shortfalls ultimately led to a reduction in mortgage lending<sup>20</sup>. Thus interest rate stickiness led to mortgage rationing in the form of mortgage queues and changes in the non-interest terms of the mortgage contract (such as loan to income and loan to value ratios)<sup>21</sup> as retail inflows were subdued and mortgage demand was encouraged. In contrast, when general interest rates were falling the competitive position in terms of retail deposits tended to strengthen and that with respect to mortgage demand to weaken, with the increased level of inflows and reduced mortgage demand allowing rationing to be lessened (leading to a restoration of liquidity levels and a subsequent expansion of mortgage lending). However, with building societies being permitted access to the market for wholesale funds since the mid-1980s, it has become the stock of wholesale liabilities rather than the liquidity ratio that has tended to adjust in the light of retail funding disequilibria; the ease with

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<sup>18</sup> Cost considerations were of particular importance in the desire to change mortgage and saving rates only infrequently.

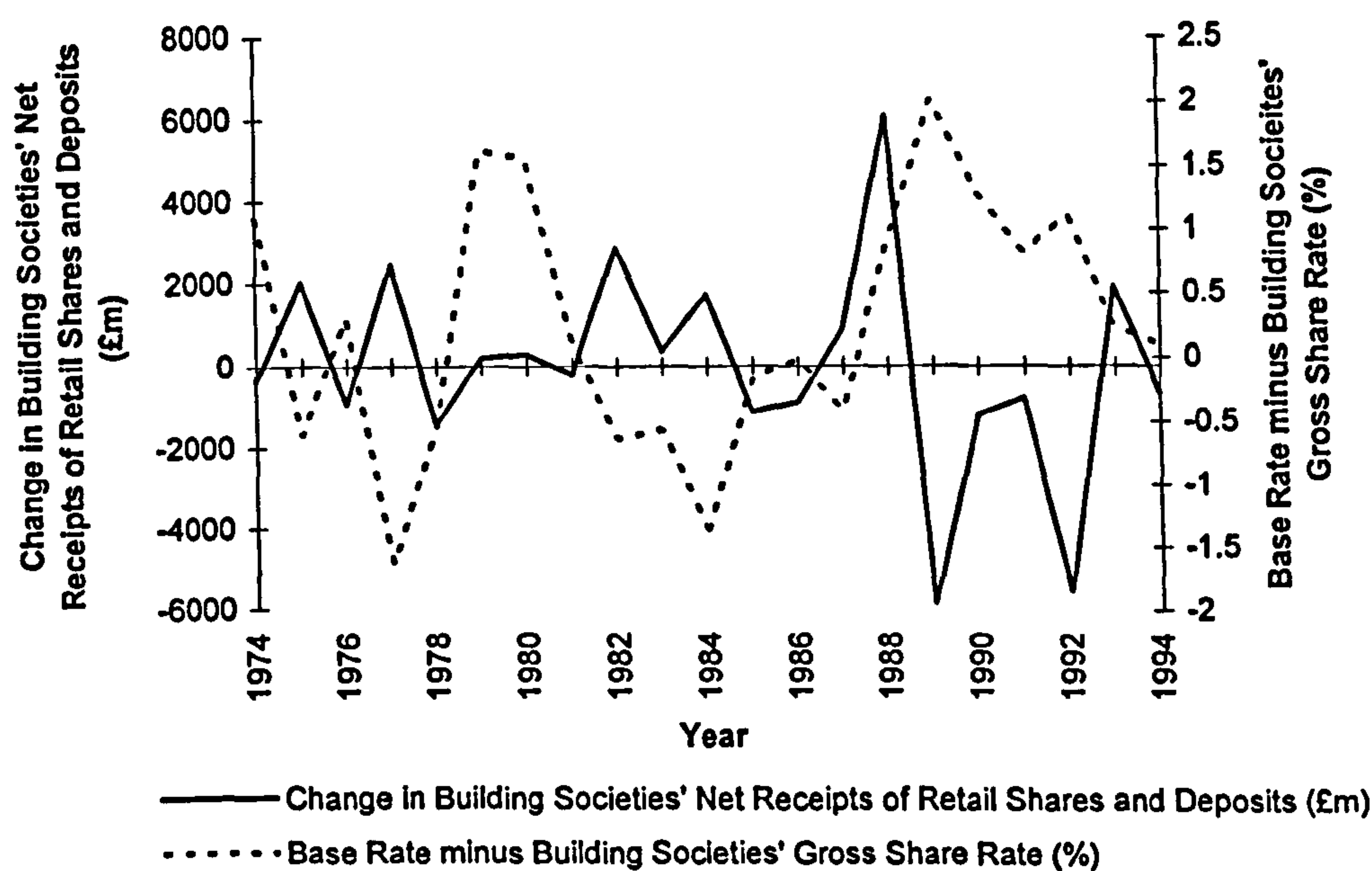
<sup>19</sup> It is noted by Suddards (1983) that a similar situation existed in South African building societies. A number of hypotheses are reviewed briefly in his paper as to the inflexibility of the mortgage rate.

<sup>20</sup> For a theoretical and empirical discussion of the determination and importance of liquidity ratios in a model of the demand for and supply of mortgage advances see Hadjimatheou (1976) Chapters 5-7.

<sup>21</sup> As we will see later in Chapter 7 of this thesis, when for any given rate of interest the adjustment of the non-interest terms of the mortgage loan is sufficient to clear the market (such as the loan to value ratio) we refer to this as 'equilibrium rationing'. When there exists excess demand for mortgages even after accounting for these terms, then we denote this as 'disequilibrium rationing', an example of which is the formation of mortgage queues or the requirement of a 'savings history' with a particular institution before being considered for a mortgage loan.

which societies (and indeed all mortgage lenders) are able to access the wholesale deposit market has meant that mortgage rationing has since become obsolete (except of course for prudential purposes).

**Figure 2.4 : The Spread Between Base Rates and Building Societies' Gross Share Rate versus the Change in Building Societies' Net Receipts of Retail Shares and Deposits**



*Sources :* Financial Statistics and Housing Finance

However, in the early 1980s building societies' retail deposit inflows weakened as a result of the highly competitive National Savings rates (and indeed the easing of these instruments' eligibility conditions) offered by the government in an attempt to fund a rising public sector borrowing requirement, or PSBR (now known as the public sector net cash requirement) as part of its Medium Term Financial Strategy (MTFS)<sup>22</sup>.

The situation was not to last long, as lower rates on National Savings (driven by a declining PSBR) and a rise in the rate of inflation meant that these instruments looked less attractive. Additionally, the introduction of high balance short notice accounts in

<sup>22</sup> It is estimated that the first issue of index-linked retirement National Savings Certificates in 1979 (otherwise known as 'Granny Bonds') removed about £1bn from the personal sector (*source* : Drake (1989)).



1981 quickly became an important source of funding for societies; in fact, according to Callen and Lomax (1990), the share of short notice and instant access accounts of building societies rose from zero in 1974 to 16.9 per cent in 1982 and 83.3 per cent in 1989. Similarly, building societies' market share of personal sector liquid assets rose from 46.1 per cent in 1981 to 52.4 per cent in 1985 (*source* : Housing Finance). However, this growth not only came at the expense of other financial institutions but also other types of building society account, again having the effect of increasing societies' average funding costs.

Prior to discussing the change in market structure which led to the ending of mortgage rationing during the early 1980s, it is useful to note at this point the importance of government policy in exacerbating rationing in the market for mortgage finance. There can be no doubt that government policy has in the past been successful in influencing the level of mortgage lending and reducing the effective rate of interest on mortgage loans. An example of government intervention in the mortgage market that contributed to influencing the demand for mortgage finance has been the tax deductibility of mortgage interest payments. The real cost of the Mortgage Interest Relief At Source (MIRAS) scheme to the government rose consistently each year from 1963 to 1977, but fell towards the end of the decade. After rising to a peak in 1991, 1996 saw the real cost fall to its lowest level since 1973 (see Figure 2.11 later in the chapter)<sup>23</sup>.

The market structure endured during the 1970s was ended with the abolition of exchange controls in 1979<sup>24</sup>, the removal of the Corset on banks in mid-1980 and the removal of the reserve asset requirement in 1981 (which specified that 12.5 per cent of banks deposits must be kept in liquid form). The removal of these lending constraints on the banks gave them the opportunity to expand into areas (such as the mortgage market) in which their previous influence had been minimal or even non-existent.

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<sup>23</sup> It is worthwhile pointing out that the introduction of capital gains tax on owner occupied housing in 1982 served to make the housing transaction less profitable, having an offsetting effect to that of the increase in mortgage tax relief during the early 1980s.

<sup>24</sup> The lifting of exchange controls encouraged the private sector to invest more readily in overseas securities and other investments. Banks then found it easy to 'disintermediate' around the corset restrictions by channelling lending to domestic customers through overseas subsidiaries, which encouraged its abolishment in June 1980.

Banks rapidly pursued the opportunities to expand their domestic balance sheets (beginning to gain market share in mortgage lending in 1981) in an attempt to make up some of the ground they had lost in the personal sector market during the 1970s<sup>25</sup>. The extent of mortgage rationing in the market meant that their goal was easily achievable. The particular appeal of the mortgage market to banks was its profitability (mortgage rates were high in the early 1980s reaching 15 per cent in the first quarter of 1982 as greater competition in the investment market pushed up the rate on savings) and the opportunity for portfolio diversification into what was seen as lower risk lending. Indeed, foreign and corporate lending had both become more risky with a significant number of LDC loans turning sour<sup>26</sup> and the recession of the early 1980s taking its toll on corporate activity. In addition, large corporations were increasingly turning to the capital markets to raise debt, forcing banks to search for new business. By 1982, the banking sector had attained a market share of net new lending exceeding 35 per cent (*source* : Annual Abstract of Banking Statistics, 1995).

However, as lending restrictions on banks were lifted towards the end of the 1970s and the early 1980s, the regulations on building societies' activities, as set out in the 1962 Act, began to bite. The Act prevented societies from undertaking corporate lending and raising wholesale funds to finance their business, giving other financial intermediaries a significant competitive advantage (as they had a greater choice over both their funding and investment strategies). As Callen and Lomax (1990) state, "banks were better able to compete in the traditional business of the building societies than were the building societies in the business of the banks".

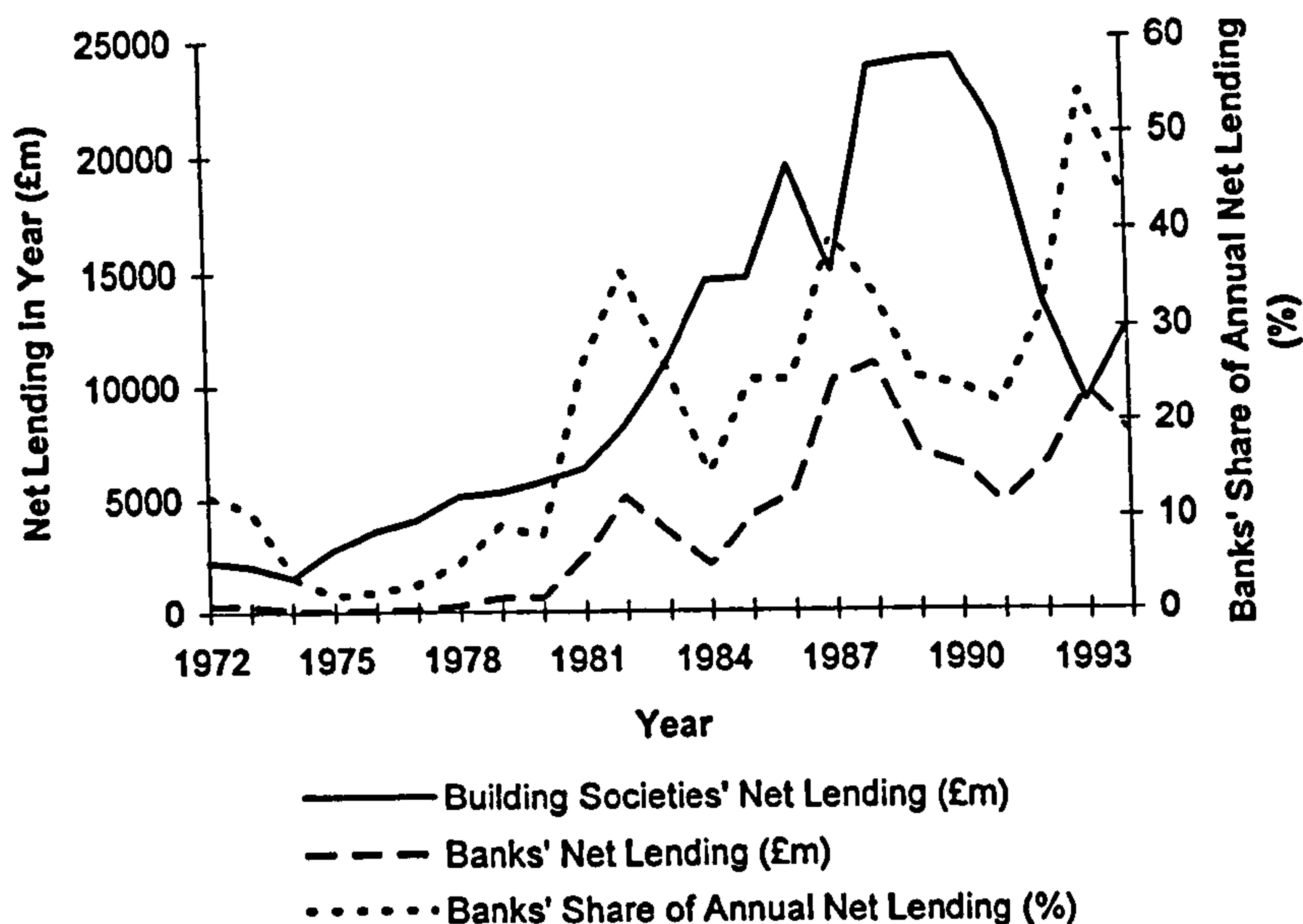
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<sup>25</sup> The extent to which the banking sector has become involved in the provision of mortgages to the personal sector is described in Figure 2.3 above.

<sup>26</sup> As is noted by Leigh Pemberton (1986), "the difficulties encountered with international lending, in particular, lending to less developed countries and for oil-related projects, have encouraged major international banks to concentrate more heavily on personal banking - a key element which is seen to be the provision of loans secured on a first mortgage". See Leyshon and Thrift (1993) for a discussion of the emergence of new types of risk within the global financial system.



**Figure 2.5 : Net Lending by Banks and Building Societies and Banks' Share of Annual Net Lending**



Note: Figures for 1989 have been break-adjusted to remove the effect of the reclassification of Abbey National from being a building society to a bank.

Source : Annual Abstract of Banking Statistics, 1995

Bank mortgage lending grew more slowly from the end of 1982 to the end of 1984 (a local peak in bank lending in 1982 is clearly visible in Figure 2.5 above) as banks had by then already achieved their initial targets and the rise in long term lending had caused a deterioration in their capital ratios. In addition, bank deposit rates were particularly uncompetitive during 1982 and 1983 (despite the fact that the BSA recommended a lower than equilibrium interest rate structure for building societies) and the resulting inadequate level of retail funds affected their ability to extend their mortgage lending. Following the breakdown of the BSA cartel in 1983 (see below for a more in depth discussion) competition for retail deposits became intense. In particular, the inclusion of banks in the composite rate system of tax deduction<sup>27</sup> from

<sup>27</sup> The composite tax arrangement enabled a financial institution to discharge the income tax liability on savings interest to the Inland Revenue on behalf of its depositors. The financial institution is charged a composite rate of tax on gross interest payments equivalent to the same amount of tax revenue as that which would be generated if all savers liable to basic rate tax had received their interest gross and had then paid their tax liabilities individually. Given that some investors were not subject to basic rate tax, the composite rate was usually lower than the basic rate. For investors subject to basic rate tax, the financial institution would automatically deduct the composite tax rate from their savings interest, whereas higher rate taxpayers would incur a further charge equal to the difference between their marginal tax rate and the basic rate.

6 April 1985 (which building societies had been subject to since 1894) proved to be immensely important in attracting deposits and thereby stimulated the increase in the growth rate of banks' mortgage lending from the middle of 1985.

The intensity of competition in the mortgage market during the first half of the 1980s had a profound effect on the market and induced a fundamental shift in building societies behaviour. As Boddy (1991) describes, "structural changes in financial markets broke open the previously protected position of the societies, forcing them to be less introspective". One particularly important behavioural change was that fewer societies adopted the rates recommended by the BSA, the system being abolished from October 1983<sup>28</sup>. The collapse of the cartel was inevitable, with its operations drawing widespread criticism from a variety of sources including both the Wilson Committee (reporting in 1980) on the functioning of financial institutions and also the Bow Group (1980)<sup>29</sup>. The main criticisms of the system were that it encouraged inefficiency in mortgage allocation and caused undesirable fluctuations in the availability of mortgage credit.

Nevertheless, the BSA continued to *advise* interest rates until November 1984 at which point it began only to co-ordinate the timing of interest rate changes and indicate their approximate size; this role was abandoned in 1986. The market moved from a situation of centrally managed building society rates to one in which the largest societies set their own rates of interest which the rest of industry would follow<sup>30</sup>. This led to further competitive pressures and diversification of business as mortgage-

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Deposit rates offered by banks were already lower than those of building societies, so the fact that banks had to start quoting net rather than gross rates to depositors from 1985 made their uncompetitive rates even more transparent to investors. Banks thus took a more competitive stance in the retail deposit market. However, an increase in banks' base rates in January 1985 (base rates rose from 10.5 per cent on 11 January to 14 per cent on 28 January 1985) which was not followed immediately by building societies meant that as banks started to quote their deposit rates net of tax (prior to April 6) they were unusually competitive. Composite tax on building society deposits was abandoned in 1991 and instead charged at the basic rate of tax.

<sup>28</sup> The Abbey National was the catalyst for the break-up of the cartel, giving three months notice of its withdrawal in September 1983.

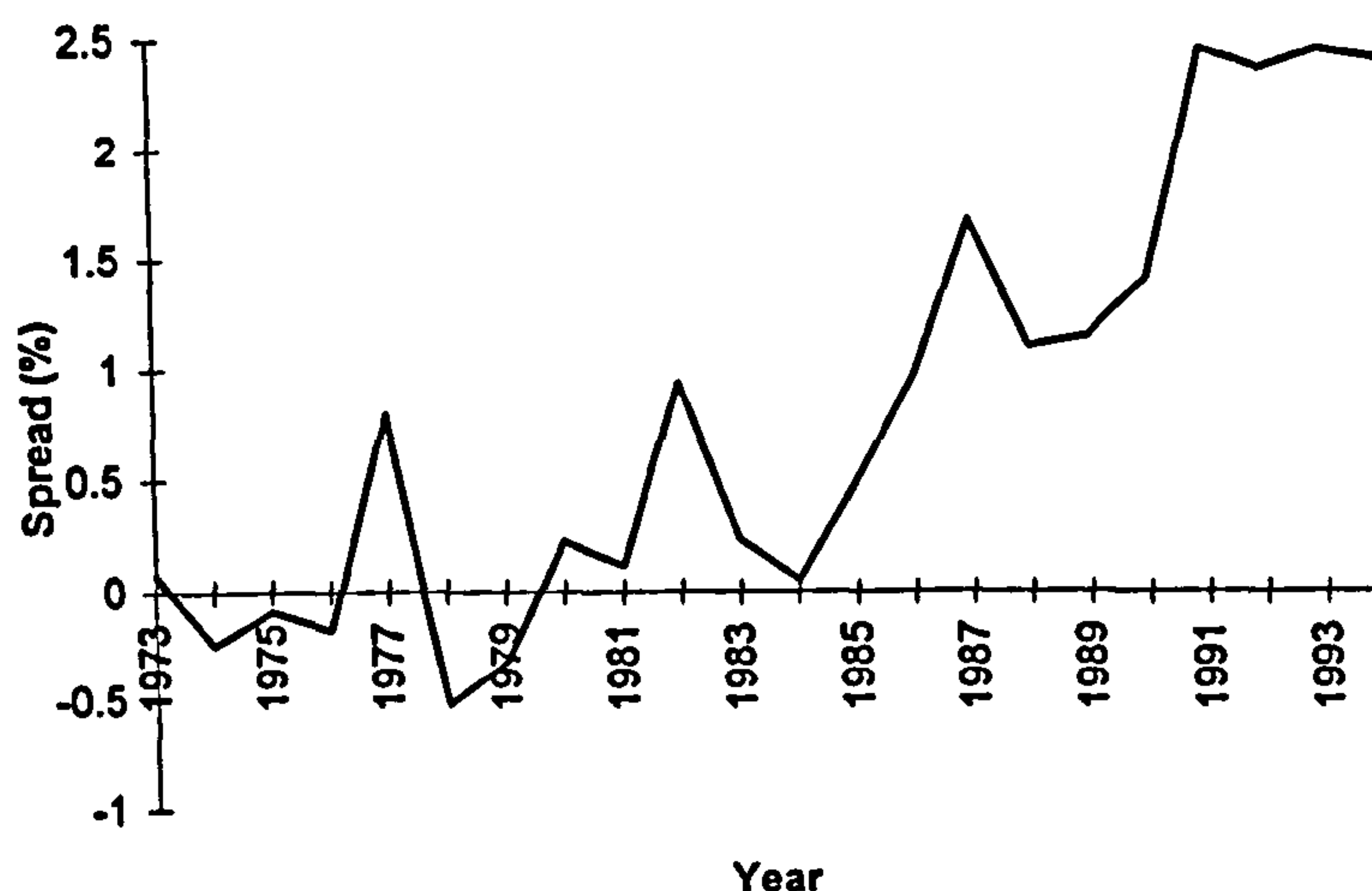
<sup>29</sup> Both reports suggested that the industry could benefit by giving the Chief Registrar powers to encourage building society amalgamation (the Bow Group went further by advocating the conversion of societies to Plc status). See Mabey and Tillett (1980) for further details.

<sup>30</sup> One suggestion for future work on the industrial structure of mortgage lending financial intermediaries is to model the industry as a price leadership oligopoly.



deposit interest rate spreads tightened further<sup>31</sup>. Figure 2.6 below illustrates this trend between 1982 and 1984, although spreads widened again from 1984 to 1987 as banks' mortgage lending growth slowed after they had satisfied their short term mortgage asset holding requirements (see previous discussion).

**Figure 2.6 : The Spread Between Average Building Society Mortgage and Deposit Rates**



*Sources : Financial Statistics and Housing Finance*

In Figure 2.6 above, the spread is calculated as the difference between the average annual lending and funding rates. It is assumed that all lending is made at the prevailing mortgage rate and that the cost of funding is a weighted average of the rate of interest on retail and wholesale funds<sup>32</sup> (the average gross share rate and LIBOR<sup>33</sup> respectively). It is apparent that the spread has widened, although this may not necessarily suggest an increase in building societies' profitability over time as some new accounts contain higher processing costs (due mainly to expensive money transmission services) making intertemporal comparison difficult. In addition, it is

<sup>31</sup> Competition has not only taken the form of interest rate strategies but also non-price forms, such as new technology, new products, increased advertising and the use of automated teller machines (ATMs).

<sup>32</sup> The weights reflect the relative proportions of outstanding retail and wholesale funds.

<sup>33</sup> LIBOR is the commonly used abbreviation for the London Interbank Offered Rate, the rate of interest at which banks offer to lend unsecured wholesale funds in the sterling interbank market (often for the purpose of liquidity management). The importance of LIBOR is that it is considered a good indicator of the marginal cost of funds for financial institutions with access to wholesale money markets.

problematic to calculate an equivalent bank spread due to the particularly fragmented nature of their savings accounts.

It has been alleged that the break-up of the BSA cartel in 1983 was encouraged not only by intense competition in the mortgage market but also competitive pressures in the market for deposits (with the inevitable consequence of increased deposit rates). As the average cost of retail funds soared, building societies found themselves particularly disadvantaged as a result of their inability to access the relatively cheaper wholesale funding market.

A number of important consequences for the demand for and supply of mortgage finance and deposits emerged as a result of the changing nature of the market in the early 1980s. With greater access to the wholesale deposit markets societies were generally able to satisfy all mortgage demand, albeit at the expense of higher mortgage and savings interest rates than recommended under the BSA cartel<sup>34</sup>. Of course this made mortgage lending particularly attractive to those institutions funded through the wholesale markets (such as banks, pension funds and insurance companies) and the need to maintain market share encouraged building societies to become more 'profit oriented' than was previously the case. Indeed, this issue is addressed in more detail later in Chapter 5 of the thesis, where a model is developed allowing a parameter to be chosen to indicate the degree to which a building society is oriented towards either the maximisation of member benefits or profit.

One of the most important consequences of the increased competition in the market for mortgages and deposits/shares was the diversification of building societies' asset and liability portfolios. This process provided the major impetus for change and culminated in legislation in the form of the Building Societies Act (1986), which aimed to recognise the changing operations of building societies. However, prior to 1986 the adoption by building societies of more positive attitudes to the diversification of their balance sheets through the provision of wider housing services

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<sup>34</sup> Meen (1990b) notes that such a fundamental change, "not only has wide implications for building societies themselves, but also potentially has important effects for personal sector housing, asset accumulation, and consumption decisions, as well as for the conduct of monetary policy".



was hampered by the legislative framework which, for example, prevented them from holding land except for their own purposes of conducting business. This is confirmed by Boddy (1991) who states that, "as the limits to expansion of owner occupied housing are approached, societies see their opportunities for expanding into new forms of housing provision". In addition, this change in attitude on the part of the building society movement has been identified by Marshall *et al* (1997) who comment that during the 1970s building societies exhibited, "a paternalistic management style, slow to change and characterised by co-operation". But it was the entry of other mortgage market players that provoked, "an aggressive response from management in some of the building societies, which adopted a more forceful and less paternalistic approach".

The diversification of building societies' balance sheets around this time was most apparent and dramatic with respect to societies' funding arrangements. As is noted by Callen and Lomax (1990), "building society expansion into the banks' liability markets paralleled the banks' penetration of building societies' traditional asset market". Although their liabilities were made up primarily of retail shares and deposits, between 1983 and 1986 a significant proportion of funds began to come from a variety of alternative sources as rising competition in the domestic retail deposit market drove up funding costs. These alternative funding instruments included certificates of deposit<sup>35</sup>, interbank borrowing, bond issuance (being rated by a major credit rating agency allowed societies easier access to the wholesale funds market), eurosterling issues (sterling time deposits held in banks outside the UK)<sup>36</sup> and eurobonds and non-sterling issues, especially after the advent of swaps allowing the conversion of non-sterling funds into sterling at a predetermined rate. Indeed, by 1986 net receipts of non-retail funds were almost equal to net receipts of retail shares

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<sup>35</sup> Certificates of deposit, or CDs, are very liquid and almost risk free negotiable (without endorsement, i.e. can be bought or sold without reference to the issuer) fixed maturity assets paying fixed (and usually low) rates of interest. They are issued by financial institutions and are analogous to interest-bearing time deposits except for the fact they may be traded (i.e. they are essentially securitised bank accounts). Changes in tax arrangements (legalised by the Finance Act of 1983) which enabled societies to pay interest gross rather than net on qualifying CDs facilitated societies' ability to access the wholesale money markets.

<sup>36</sup> The eurosterling floating rate note (FRN) market proved particularly popular as it was able to provide societies with relatively cheap long term funds (FRNs are medium term debt securities that pay floating rate coupons).



and deposits (see Figure 2.8 later in the section). As Hamnett (1994) writes, “even the flow of funds into housing is being internationalised, with mortgage backed securities and bonds increasingly traded on and between the major financial centres and large scale loans raised on the euromarkets”<sup>37</sup>. As a result, however, the UK housing market became less insulated from the performance of the global economy, and in particular the forces that drive global interest rates; this again served to stimulate competition.

The Building Societies Act of 1986, which came into force on 1 January 1987 (see Section 2.4 for a more thorough discussion of the Act and its implications), recognised the desire of building societies to diversify both their asset and liability base. A particularly important measure of the Act was to allow wholesale funding up to 20 per cent of a society’s total liabilities (40 per cent from January 1 1988 and 50 per cent following the Building Societies Act of 1997) which helped to lower the cost of building society funding and reduced their reliance on retail deposits. Adherence to the new regulations was overseen by the Building Societies Commission (BSC), replacing the Chief Registrar of Friendly Societies. Leyshon and Thrift (1993) state that prior to the legislation of the 1980s, “financial institutions were subjected to a system of ‘structural regulation’, whereby different types of firms were limited to prescribed areas of the financial system, although the degree to which their activities were supervised was often minimal. Now, financial institutions have greater freedom to compete across a wider range of markets, but they are subject to a higher level of surveillance”.

The introduction of the Building Societies Act (1986) coupled with rapid concentration in the mortgage finance industry<sup>38</sup> has helped rectify building societies’ loss of market share to banks by allowing new lines of business to be pursued. The Act gave societies the authority to conduct foreign exchange, estate agency and

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<sup>37</sup> Leyshon and Thrift (1993) analyse the separate effects of domestic re-regulation and global disintermediation in increasing competition in the domestic and international markets for financial services.

<sup>38</sup> In 1995 the 3-firm, 5-firm and 7-firm concentration ratios in the building society industry (as rated by total assets) were 54.5 per cent, 67.3 per cent and 76.9 per cent respectively (*source* : Thesys Information Ltd.).



insurance services together with full money transmission. Despite retaining their mutual status and memoranda underlining their primary aim of providing housing finance, an important corollary of the legislation has been to allow societies to develop into very similar institutions to banks (in terms of their financing and product lines). In the immediate years following the legislation coming into force, societies' expansion in non-traditional activities permitted by the 1986 Act was modest, mainly due to the buoyancy of the mortgage market at the time. Callen and Lomax (1990) argue that factors such as the increase in house prices, the rise in owner occupation (which grew from 54.7 per cent of the housing stock in 1979 to 66.4 per cent in 1993, facilitated in part by the decline of the rental sector), the number of new households, the withdrawal of housing equity, rising real incomes and financial deregulation all contributed to the boom in the market for housing finance during the latter half of the 1980s. In addition, changes in government policy have proved to be instrumental, including the transfer of local authority housing stock to individual owners under the 'right to buy' scheme of the 1980 Housing Act. It is only as mortgage business slowed down during the early 1990s (as a result of the collapse in the housing market) that societies have taken on considerably more non-traditional business and have demanded (and received) new legislation to extend their business further.

However, not only has it been the case that building societies have ventured into the traditional areas of business of other financial intermediaries, but the reverse has been true also. During the mid-1980s, the rise in the mortgage rate to almost 14 per cent made mortgage assets attractive to institutions which had no branch-based network and traded mortgages in the secondary market (these institutions became known as 'third tier' institutions). By using the wholesale markets to finance their business, these institutions could attract a considerable amount of finance at a lower cost than the rate on retail funds. As such, when the structure of rates moved upwards (as it did during the mid-1980s), third tier institutions benefited at the expense of building societies which were limited to financing their activities through the retail sector. Combined with excess demand in the mortgage market, this provided the impetus for the new mortgage lenders to participate, an example being the National Home Loans

Corporation (NHLC) which was floated in September 1985 acquiring its asset portfolio from a variety of other mortgage lending institutions.

Innovation in both the mortgage and deposit markets has enhanced consumer choice over the past two decades as competitive pressures have forced lending institutions to focus more directly on the need to attract customers. Besides undercutting the mortgage rate offered by high street banks and building societies, third tier institutions have been catalysts in the provision of highly innovative products such as LIBOR linked loans and fixed rate mortgages. Recently, the housing finance industry has seen further and more dramatic innovative products being marketed by all types of mortgage lender including banks and building societies. For example, the Halifax Plc, the Woolwich Plc, National Westminster Bank and the Bank of Scotland have recently all launched 'rental mortgages' designed for investors wishing to purchase or re-mortgage a property for the purpose of letting. Some of these products take into consideration the *expected* rental income in addition to offering the benefits of a standard variable rate mortgage (see Sunday Times (1997)). Many of these schemes offered by the institutions are part of the Buy to Let scheme set up by the Association of Residential Letting Agents (ARLA).

Repayment flexibility has become an important innovation in mortgage provision in recent years as lending institutions have recognised the need to approach the problem of arrears and possessions (see Chapter 4 for a full discussion of the problems of mortgage arrears and possessions in the UK mortgage market during the early 1990s). The Mortgage Trust, for example, unveiled a new mortgage in September 1997 (called the 'Early Payment Plus' mortgage) enabling the borrower to vary their monthly repayments and reduce the term of their loan by repaying greater monthly sums, taking 'payment holidays' and to withdraw cash from accrued overpayments (see Chapter 3 for a review of more standardised mortgage designs). However, the main innovative feature of their product was the combination of mortgage flexibility with a period of fixed-rate repayments. In fact, a survey undertaken by the Council of Mortgage Lenders confirmed that two thirds of lenders now offer flexible mortgages.



Remaining on the theme of product innovation and new entrants to the mortgage market, the financial deregulation of the 1980s also prompted insurance companies to enter the market (particularly towards the end of the 1980s) as competition in the insurance industry and the ability to offer a wider range of services associated with the house purchase has prompted diversification (some insurance companies, such as the Prudential and Direct Line, have begun to offer 'telephone mortgages')<sup>39</sup>. The entrance of insurance companies into the mortgage market has been crucially dependent on the cost of wholesale funds; policy-holders' funds are rarely if ever used to finance a mortgage portfolio since the returns are deemed insufficient. Insurance companies have followed one of two paths, either acting as intermediaries selling mortgages provided by other lending institutions or offering their own products (this concept, known as 'polarisation', will be addressed later in the chapter). Figure 2.7 below confirms the trend in real mortgage lending by insurance companies and pension funds which bottomed out in the early 1980s, from where it continued towards a peak in the final quarter of 1988 (primarily due to the upward movement in the structure of building society interest rates) before resuming a declining path during the 1990s. Likewise, the fall in insurance companies' real mortgage lending from 1989 onwards is associated with a period in which building societies' retail inflows (and thus mortgage loans) became relatively cheap (see Figure 2.4 below).

A particularly popular form of mortgage instrument during the 1980s was the endowment mortgage, enabling insurance companies to take a more active role in the market for housing finance. An endowment mortgage requires the borrower to repay only the interest on the loan each month, the principal being repaid at the end of the term by the final proceeds of an endowment policy. The appeal of this type of loan proved to be the life assurance element of the endowment, which guaranteed repayment of the loan on the death of the borrower<sup>40</sup>. At the height of their popularity during the mid- to late 1980s, endowment mortgages accounted for more than 80 per cent of new mortgage lending, dwarfing repayment mortgage business. However,

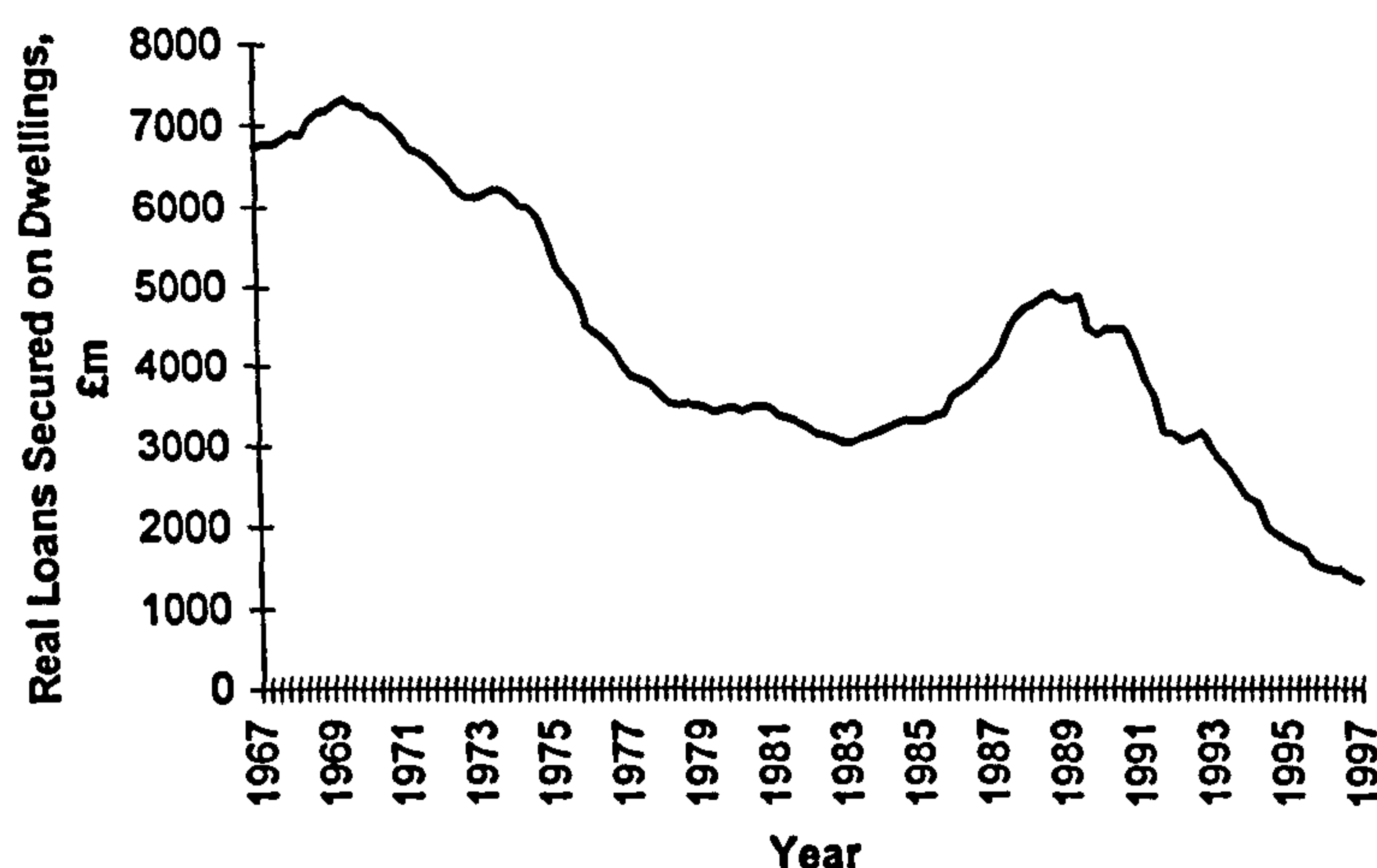
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<sup>39</sup> Not only have building societies faced new competition from insurance companies but other operators such as retailers (examples include Marks and Spencer, Tesco and Sainsbury's).

<sup>40</sup> For borrowers later in the life cycle this may not be an advantage since the cost of an endowment policy will be a positive function of both age and health.

their popularity was not to last, with the proportion falling markedly to around only 30 per cent today. This has been an important factor in the decline of insurance companies' mortgage business during the 1990s.

**Figure 2.7 : Real Level of Mortgage Loans Outstanding at 1990 prices: Insurance Companies and Pension Funds**



*Source : Financial Statistics*

There are a number of reasons for the fall from grace of the endowment mortgage, the first being its inflexibility. With the terminal bonus constituting a significant portion of the overall return to the endowment, the surrender value of an endowment policy is low<sup>41</sup>. This is made worse by the fact that a significant amount of the investment in the initial years is taken up by up-front charges<sup>42</sup>. In addition, endowment policies rely on long run equity market returns; there is no guarantee that the stock market will have appreciated enough to give the holder a profit if the policy is surrendered before maturity. Remaining on the issue of inflexibility, endowment mortgages are not extendable, unlike repayment mortgages under which it may be possible to suspend capital payments in times of repayment difficulty.

<sup>41</sup> That said, a better deal may be attained from selling the policy on the secondary market, although the market only exists for policies of a specific type and over a certain age.

<sup>42</sup> Higher up-front commissions are paid to advisers selling endowment policies rather than repayment mortgages, encouraging the recent allegations of mis-selling.



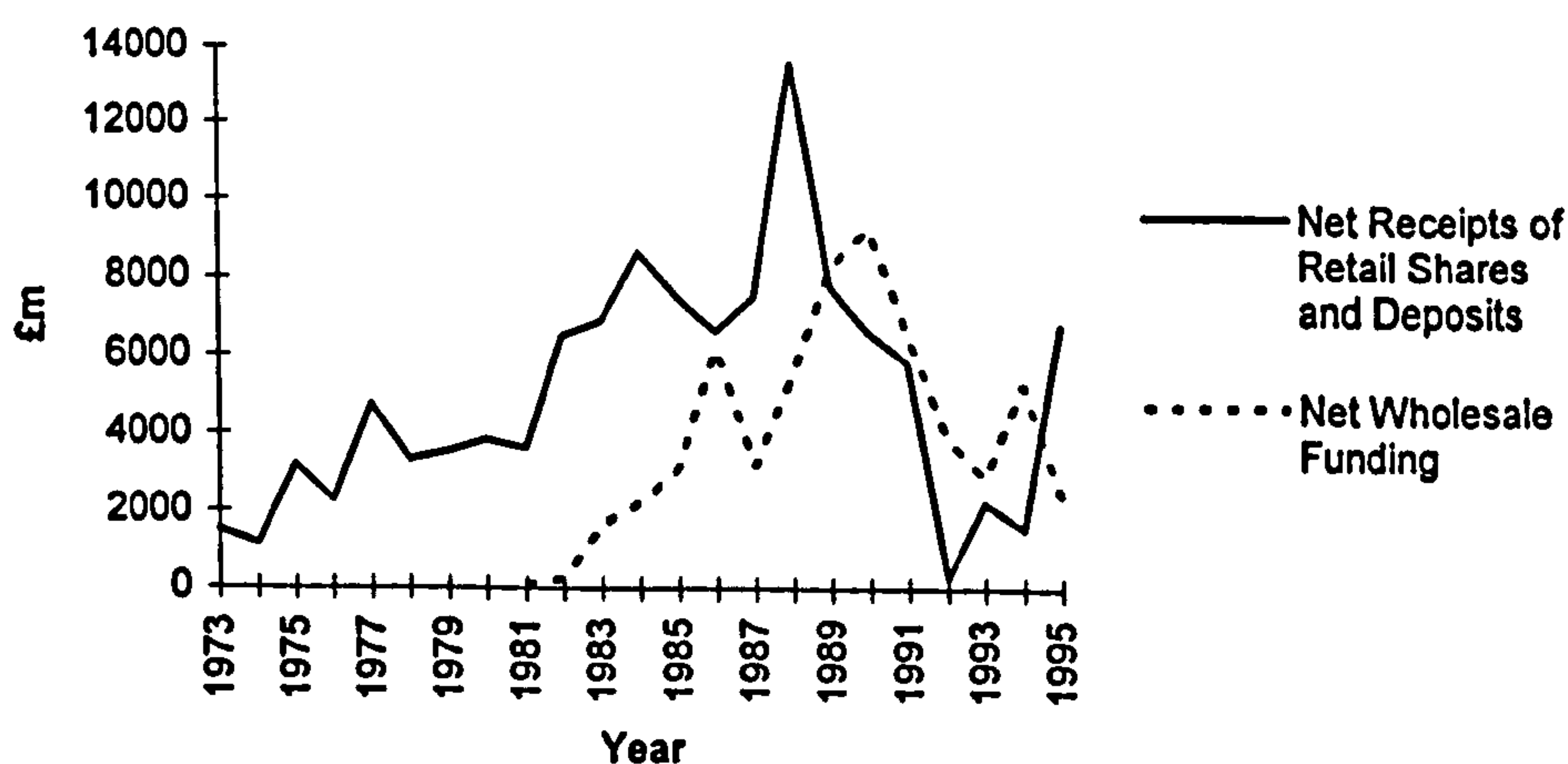
Secondly, with equities typically forming a large portion of endowment portfolios, there is a risk that the terminal value of the endowment may not be sufficient to repay the mortgage. Indeed, the 1987 stock market crash hit new policy holders particularly hard, whereas policies taken out during the 1970s had already had time to accumulate large surpluses. In cases when the endowment looks like falling short of its terminal target, the insurer may suggest an increase in the borrower's monthly contributions.

Finally, there are a number of issues associated with the fact that the principal remains unpaid in its entirety until the end of contract. It has been suggested that this can exacerbate the problem of negative equity in the short term as the borrower has, in effect, made no repayments to the principal sum. In addition, the move upwards in interest rates towards the end of the 1980s discouraged endowment loans as the increased cost of borrowing applies to the *whole* sum borrowed, rather than only the principal remaining (as with a repayment mortgage). This argument only holds, however, if the rise in interest rates exceeds the increase in the rate of return on the endowment. Nevertheless, cash flow problems may result from the fact that the capital gain on the endowment is not realised until maturity.

After relatively subdued growth in banks' mortgage lending portfolios in 1984 (see Figure 2.2), expansion of around 15 per cent stimulated competition in the market once again in 1985. Innovations by banks in the mortgage market were of particular importance in securing this growth, although they were also obliged to offer competitive savings products in order that sufficient retail deposits could be attracted to ensure that mortgage demand was met in full. Both were achieved by banks making use of cross selling opportunities throughout their extensive branch network. However, as Leyshon and Thrift (1993) note, the combination of increased competition and contracting markets at various points in time during the 1980s and 1990s stimulated financial intermediaries to, "systematically reduce costs and introduce strategies which seek to make better use of their human and fixed capital resources".

It is hardly surprising then that building societies experienced negative growth in their mortgage books during 1987, dipping to almost -20 per cent in 1989 (see Figure 2.2 above, although some of this fall would have been a result of the Abbey National conversion). Drake (1989) points out that in an attempt to minimise the problem of the rising cost of retail funds, in 1986 building societies both reduced their liquidity ratio to within 1 per cent of the BSC's suggested minimum of 15 per cent (primarily through gilt sales) and increased their presence in the wholesale funds market; this latter trend is illustrated in Figure 2.8 below which shows that the net inflow of funds from the wholesale market in 1986 was almost the same as that from traditional shares and deposits. The former measure to arrest the declining growth in deposit inflows (and thus mortgage lending also) could only ever be temporary, and mortgage lending fell in the subsequent three years. The fall in deposit inflows was accentuated between the middle of 1986 and the end of 1987 as wholesale money became cheaper than retail funds (see Figure 2.9 below), leading to the inability of building societies to maintain their share of total mortgage lending.

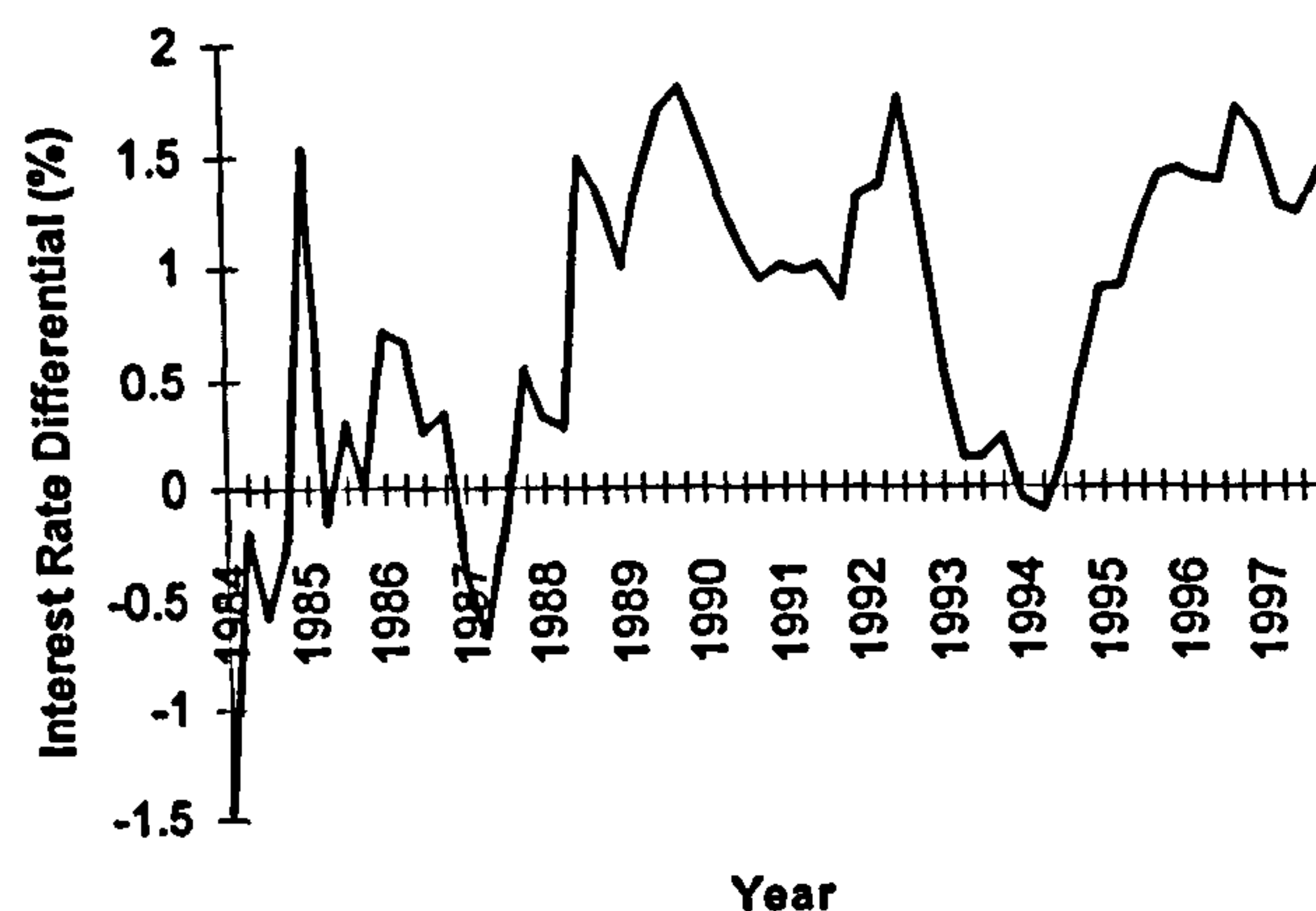
**Figure 2.8 : Net Wholesale Funding versus Net Receipts of Retail Shares and Deposits for Building Societies**



*Source : Financial Statistics*



**Figure 2.9 : Difference Between the 3 Month Sterling Interbank Rate and the Average Gross Share Rate Paid on Building Societies' Deposits**



*Source : Financial Statistics*

Indeed, the plight of societies' (with regard their funding requirements) was made even worse as significant levels of personal sector funds were invested in unit trusts, Personal Equity Plans (launched in 1987)<sup>43</sup> and the big-name privatisations of 1986 and 1987. As a result, building societies' net receipts proved to be extremely volatile (as illustrated in Figure 2.4 above)<sup>44</sup>.

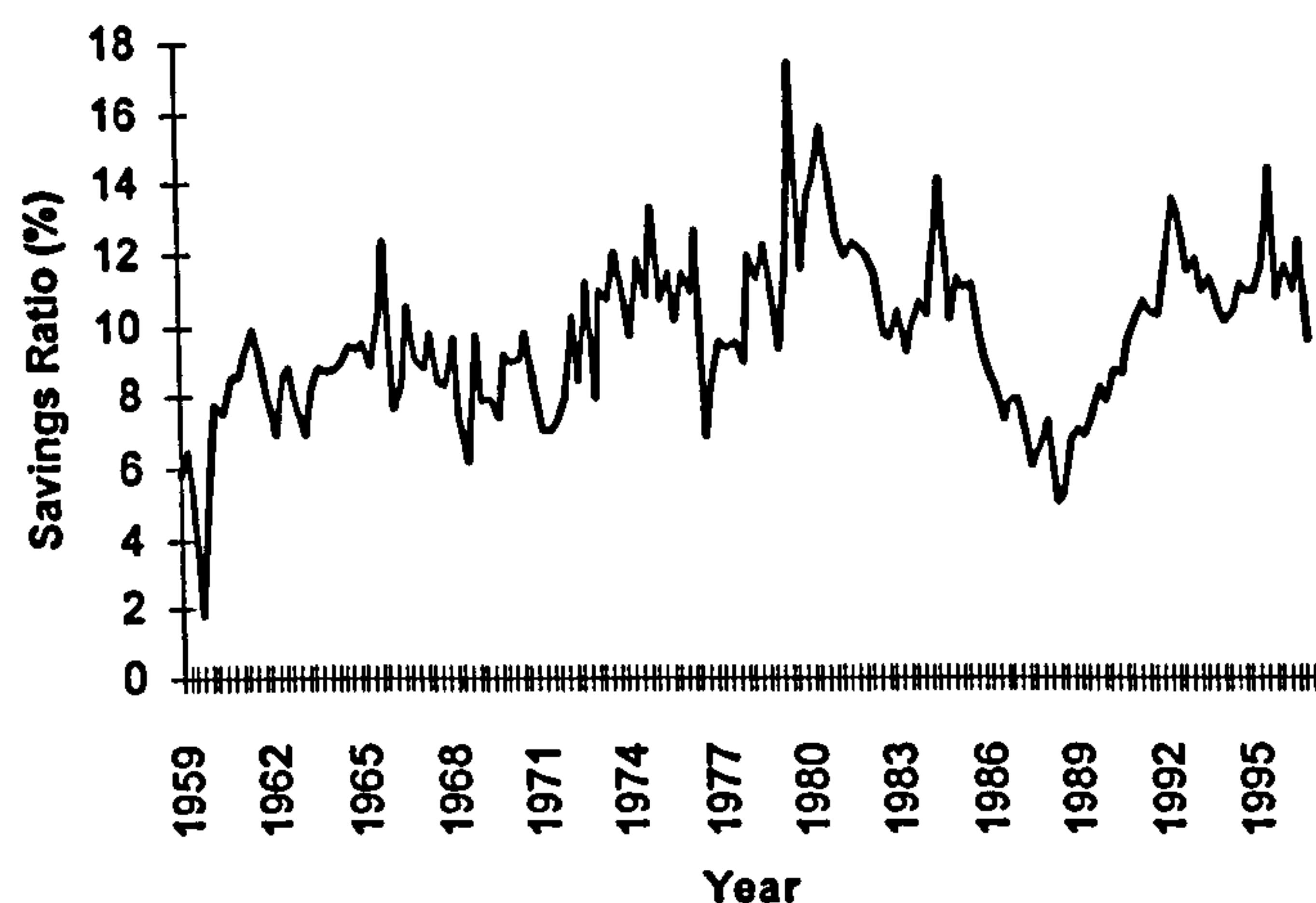
However, the outlook for building societies improved somewhat towards the end of 1987 and the beginning of 1988. The wholesale funding limit was increased from a maximum of 20 per cent of total liabilities to 40 per cent in January 1988 and the cost of retail deposits began to fall relative to that of wholesale funds (see Figure 2.9 above). The latter was largely due to the fall in competition for retail funds resulting from the 1987 stock market crash (at £5,314m, the net increase in societies' retail shares and deposits in the final quarter of 1987 was the third largest on record) and the start of an uptrend in the personal sector savings ratio in 1988 (Figure 2.10 below illustrates that in the third quarter of 1988 the savings ratio had fallen to less than 5

<sup>43</sup> Between the second quarter of 1985 and the third quarter of 1987, the total amount of outstanding funds in unit trusts and PEPs together more than doubled.

<sup>44</sup> Building societies were particularly badly affected by the TSB and British Gas flotations during the Autumn of 1986, with their net receipts falling from £2220m in the first quarter of 1986 to only £168m in the third quarter of 1986 (*source* : Housing Finance). As Callen and Lomax (1990) write, "the banks proved more successful in maintaining their position when the personal sector's interest in equities revived in the second half of the decade [1980s]".

per cent, its lowest level for almost 30 years). With the increased availability of cheaper retail funds, the growth rate of real mortgage lending by building societies rose from almost -20 per cent in 1989 to 15 per cent in 1990. In contrast, however, the position of wholesale funded institutions worsened as a result of the fall in the mortgage rate relative to LIBOR (the cost of wholesale funds).

**Figure 2.10 : The Personal Sector Savings Ratio (seasonally adjusted)<sup>45</sup>**



Source : Financial Statistics

In retrospect, however, the expansion of building societies' mortgage books in the late 1980s was not to be envied given the significant and protracted fall in housing turnover and prices from 1989. The effects of the slump in the housing market, precipitated by dramatic interest rate rises between 1988 and 1989, was considerably worsened by the onset of recession. Not surprisingly, given their expansionary lending policies (during 1988-90 in particular) it was the building society movement more than the banking sector that suffered as a result of the accumulation of arrears and the necessity to possess the properties of households which had defaulted on their debt. The situation was compounded by the absence of mortgage insurance guarantees<sup>46</sup>, with societies' loss provisions increasing dramatically towards the end

<sup>45</sup> The seasonally adjusted personal sector savings ratio is used since the savings ratio is particularly affected by seasonal swings, making the unadjusted time series plot incomprehensible.

<sup>46</sup> Insurance guarantees repay the lender the difference between the sale price of a possessed house and the mortgage owed on it up to a certain amount. Such guarantees were in general not taken out by the societies and in cases where they were, the amount of cover tended to be insufficient to compensate societies fully for losses made on possessed houses.



of the decade. As Doling and Ford (1991) note, "the mortgage market throughout the 1980s was characterised by increased uncertainty for the building societies about which customers would meet their monthly repayments and which would not. No longer could they sit back with the knowledge that the money would more or less automatically be repaid". Mortgage loans advanced by third tier lenders in particular mushroomed during the late 1980s with their business being based on high loan to income and loan to value ratios. As such, the slump in the housing market had devastating effects on this type of lender, suffering more than most from arrears and possessions at a time when falling nominal house prices meant that mortgage lending was less secure<sup>47</sup>. As Leigh Pemberton (1986) warned, "there is no economic law that dictates that house prices will necessarily travel in an ever upward direction ... lending policies should not be based on the premise that house price rises will continue apace".

More prudent lending policies were re-imposed in the early 1990s with the average loan to value ratio for first time buyers reaching a nine year low in the first quarter of 1991 at 81 per cent (*sources* : Housing Finance and the Building Societies Association Bulletin). The lax attitude of lenders to arrears (which could be attributed to the apparent guarantee of the value housing collateral as security) was abandoned in favour of improved arrears monitoring techniques, special debt helplines and debt counselling services (following advice contained in the Council of Mortgage Lenders code of practice) as more attention was paid to risk management and risk reduction. Mortgage lenders have additionally introduced mortgage schemes that ease the burden of repayment (and thus reduce the likelihood of arrears or possession) on the mortgagee<sup>48</sup>. However, as the housing market has picked up again societies appear to have almost entirely dismissed the problems they faced during the early 1990s; the average loan to value ratio for first time buyers stood at an all time high of 91.2 per cent in the second quarter of 1997 with the average loan to income ratio for first time

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<sup>47</sup> Doling and Ford (1991) discuss that, "in these circumstances, the house ceases to be collateral and being 'safe as houses' becomes as untrue for the lender as it has become for the borrower".

<sup>48</sup> An example of such a scheme is the shared equity mortgage, in which a household purchases a share of equity in the housing asset (e.g. 50 per cent) and rents the remainder, with the right to purchase further tranches of equity later.

buyers at 2.25 (the only period in which the loan to income ratio has been higher was in the third quarter of 1973 when it stood at 2.26).

In addition to the change in the management of arrears over the 1980s and 1990s, it is important to note that the profile of defaulters has changed during the 1980s. The relatively slight increase in arrears in 1981 could be attributed mainly to increases in unemployment and rising loan to value ratios, whereas the significant increases in arrears of the early 1990s occurred as a consequence of the combination of a number of factors : high mortgage interest rates, the onset of recession and rising unemployment, falling nominal house prices and less conservative lending policies during the 1980s.

Both the mortgage and deposit markets in the 1990s have become ones in which competitive forces play an ever important role. It is impossible to understate the importance of the legislative framework under which building societies and banks have operated in shaping the mortgage market during the past two decades. Not only has it been responsible for influencing the *balance* of mortgage lending between mutual and non-mutual financial institutions, but has also had a considerable impact on the *total market turnover* of mortgage lending and the terms on which such funds are lent. Potential borrowers who were frequently frustrated in the past now find that loans are more freely available given that certain prudential criteria are met<sup>49</sup>. There are grounds, therefore, for believing that the regulatory environment and institutional structure of the mortgage market have been partly responsible for the more rapid growth in mortgage lending since 1980 and thus also for the rapid increase in mortgage default during the early 1990s. Given its importance, it is the regulatory framework and its effect upon mortgage lending to which we now turn.

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<sup>49</sup> As we discussed earlier, however, such criteria have been relaxed as a result of increasing competitive pressures in the mortgage market throughout the 1980s.



## **2.4 THE REGULATORY FRAMEWORK FOR BUILDING SOCIETIES IN THE 1980s AND 1990s**

Prior to 1986, the original legislation governing building societies' behaviour was that of the 1874 Building Societies Act, which was gradually amended with the last of the changes being consolidated by the Building Societies Act of 1962. By the early 1980s, however, it was clear that the legislation had become inappropriate and outdated, with building societies being restricted from full participation in the rapidly changing competitive environment. Legislation in the form of the 1986 Building Societies Act made some considerable headway in attempting to rectify the situation.

### **2.4.1 The Building Societies Act (1986)**

It is worth briefly considering the motives for the introduction of the Building Societies Act of 1986 and the key role played by the Building Societies Association in securing the desired regulatory framework (see Boddy (1991)).

During the period prior to the Building Societies Act being passed in July of 1986, the role of the BSA was crucial in securing the most appropriate legislation on behalf of the building society movement, and was given considerable access to the legislative process<sup>50</sup>. The first formal proposals made by the BSA to the government appeared in a 1984 consultation document<sup>51</sup>, where it was suggested that societies be permitted both to broaden the scope of their property based business and also be allowed to offer financial products more akin with those offered by the banking sector.

However, it was not only the building society industry that had been pressing for legislative change. Indeed, pressure had come from the European Community in an attempt to create a 'level playing field' in financial services, to which the government

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<sup>50</sup> Boddy (1991) notes that this was only possible in a new political climate of consensus, in contrast to, "the more formal structures of the 1970s" which were, "symptomatic of more conflictual relations". In political terminology, the incorporation of industry groups into the legislative process has been referred to as 'corporatist interest intermediation'.

<sup>51</sup> The paper (entitled "New Legislation for Building Societies") resulted from the conclusions of a discussion group headed by John Spalding, then the chief executive officer of the Halifax building society.

was particularly responsive given the differential legislative background of domestic institutions (i.e., mutuals versus non-mutuals) and the lack of accountability in the building society industry (see Section 2.5 for a discussion of the existence of agency problems in the mutual sector).

The Building Societies Act of 1986 (which came into force on 1 January 1987) established an entirely new structure under which building societies were to operate. The responsibility for the prudential supervision of building societies under the Act was assigned to the newly formed Building Societies Commission (BSC) which was to take over from the office of the Chief Registrar of Friendly Societies<sup>52</sup>.

On the liabilities side, the Act set out limits on the use of wholesale funding, allowing societies to raise funds other than through traditional retail deposit taking channels. It was specified that non-retail funds were not to exceed 20 per cent of a society's total liabilities, with provision made for this figure to be increased to 40 per cent by statutory instrument (which it was from January 1 1988 as the initial limit began to restrict some larger societies from expanding their business). In addition, societies were obliged by the Act to maintain a 'reasonable' liquidity ratio, although liquid assets were not permitted to rise *above* one third of a society's total asset base.

On the asset side of the balance sheet, building societies were permitted to undertake unsecured lending business (as originally requested in the Spalding report) to enable them to compete more effectively in areas of traditional banking business activities. However, the Act constrained societies as to the proportion of different classes of lending they were permitted to undertake; these restrictions are summarised in Table 2.1 below.

In addition, the Act allowed building societies to provide a range of services that had been previously restricted or outlawed such as personal credit provision, house buying

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<sup>52</sup> As of 1997, however, all financial institutions, whether they be privately owned, publicly owned or mutual come under the prudential supervision of the newly formed Financial Services Authority.



services (comprising estate agency services, conveyancy and surveys<sup>53</sup>), pension provision and, from July 1989, making investments in other mortgage finance companies (including third tier institutions). The *complete* range of housing services permitted by the act were, however, restricted to societies holding commercial assets of over £100m, with smaller societies being barred from offering estate management services, providing personal equity plans (PEPs) or operating foreign subsidiaries to lend within the EC<sup>54</sup>. Specifically, the Act restricted the ability of societies to diversify their business activities by categorising each society into one of five groups ordered by asset size (A1, A2, B, C, D), with membership of the largest grouping (category A1) requiring the society to have an asset base over £7.5bn.

**Table 2.1 : Asset Categories and Limits of the Building Societies Act 1986**

Category	Description	Initial Limits	1990 Limits	1991 Limits	1993 Limits
Class 1	First mortgage loans secured by owner occupied housing	Minimum 90 %	Min 82.5 %	Min 80 %	Min 75 %
Class 2	Other advances secured on property, including loans to housing associations and builders, loans on non-residential property, and second mortgage loans on owner occupied houses	Together with Class 3, not more than 10 %	Together with Class 3, not more than 17.5 %	Together with Class 3, not more than 20 %	Together with Class 3, not more than 25 %
Class 3	Unsecured loans up to £5,000 (£10,000 following a Treasury review in February 1988), acquisition and development of land, investments in subsidiaries and associates	Not more than 5 % unsecured lending; requires societies to have at least £100m of commercial assets (as does the acquisition and development of land)	Unsecured lending not more than 7.5 %	Unsecured lending not more than 10 %	Unsecured lending not more than 15 %

*Source : Drake (1989)*

The BSC conducted a radical overhaul of Schedule 8 of the Act in May 1988, allowing building societies to undertake activities in the following broad business

<sup>53</sup> This new range of housing services (made available under Schedule 8 of the Act) led to concerns being expressed by estate agency, legal and surveying businesses who were understandably apprehensive about the likelihood of increased competition in the industry.

<sup>54</sup> The latter was made available to societies with over £100m in commercial assets as of 1 January 1988.

areas unless specifically restricted : banking, investment and insurance services, trusteeship, executorship and land services<sup>55</sup>. This revised Schedule 8 conferred an important range of new powers upon building societies. For example, as a result of the revision, building societies were permitted to own life insurance and stockbroking companies (but only up to a 15 per cent stake in a general insurance company due to the higher risks involved), and can in general offer a far wider range of traditional banking services<sup>56</sup>. Finally, the revision to Schedule 8 allowed both an enlargement in the composition of non-mortgage assets and provided for increases in the legal maxima of such assets that may be held by societies (via the use of statutory instrument rather than further primary legislation); as Table 2.1 above shows, the extension of these percentage limits was achieved reasonably quickly.

As we have seen above, the majority of provisions of the 1986 Act related to the extension of societies' business into areas traditionally dominated by the banking sector. Indeed, societies were permitted by the Act to make the ultimate move towards expanding into the banking sector : the permission to convert to public limited companies. The Act required that stringent conditions be met in order that any conversion may take place, perhaps the most burdensome being the demanding voting requirements. This, it was hoped, would not only ensure that each conversion was in the best interests of the society but would also help regulate the tide of societies expected to want to abandon their mutual status. Nevertheless, the Act contained provisions to encourage societies to convert; for example, it barred any group from holding in excess of 15 per cent of a converted institution's shares during the first 5 years of its operation in order that early and possibly unwelcome take-over bids may be prevented.

Finally, with respect to intra-industry mergers, the Act specified that the distribution of excess reserves as windfall payments following a merger must not exceed 1 per cent of the society's total assets in order to discourage unsuitable alliances based

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<sup>55</sup> Restricted services have tended to be those relating to corporate banking activities.

<sup>56</sup> Ball (1990) refers to these new emerging multipurpose financial institutions as 'financial supermarkets'.



solely on the size of a target's reserve ratio. Both society mergers and conversions are discussed in more depth in Section 2.5 below.

#### **2.4.2 The Building Societies Act (1997)**

Even before 1990, building societies were beginning to view the 1986 Building Societies Act as over-restrictive. Although it may have generally been considered appropriate at the time of enactment, a constant stream of statutory instruments were required to amend the legislation in the light of the rapidly changing mortgage and deposit markets. Because of these frequent and very involved changes to the legislation under which building societies operated (requiring societies to regularly change their rules and memoranda<sup>57</sup>), the movement began to argue that it should be regulated as is any other listed financial organisation (i.e. by a combination of prudential supervision of their operations by the newly instituted Financial Services Authority and regulations set out by the Banking Act of 1987 and the Companies Act of 1985).

Following a review of the 1986 Building Societies Act during 1994 and 1995, the Conservative government announced in March 1996 draft legislation to be speedily enacted prior to the general election of May 1997. The Building Societies Act of 1997 allowed societies to acquire up to a maximum of 50 per cent of their funds from the wholesale money markets and to hold up to 25 per cent of their assets in the form of non-mortgage loans, as long as the particular society is able to convince the regulator that it has sufficient financial and managerial resources to take on the activity. Subject to these two constraints (and some other restrictions on transactions involving securities, commodities, currencies and derivatives), societies are now broadly free to decide on the purposes and powers set out in their memoranda. Many societies changed their memoranda prior to their annual general meetings in the Spring of 1998 to incorporate the provisions of the 1997 Act, the changes being put to the voting

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<sup>57</sup> The memorandum of a building society is a document specifying its purposes and powers as opposed to its rules, which contain the constitution and procedures of the society (such as the definition and rights of a member, procedural and voting rules for the annual general meeting and the role of the board of directors, etc.).

members of the society for approval. Rather than specifying particular areas of business in which the society will develop, societies' management have generally asked their members to vote for a flexible memorandum authorising the extension of their range of activities in the changing market as and when the management desires. The Act also gives borrowing members the same rights as shareholding members (namely the ability to vote at the AGM, nominate prospective directors, propose resolutions and propose special general meetings).

However, the Act was criticised for being too little too late, as the process of de-mutualisation (which started as far back as 1989 with the Abbey National) had become unstoppable. The largest societies in the UK (such as the Halifax and the Abbey National) had already decided to forgo their mutual status in exchange for public limited company status (see Table 2.3 of Section 2.5). This enabled them to operate under more relaxed regulations in order to expand their previously constrained operations predominantly in the area of mortgages and savings but also in the more broadly based financial activities permitted by the Banking Act of 1987.

The Building Society Acts of 1986 and 1997 have transformed the market for housing loans from being a specialist lending market towards a group of profit oriented financial conglomerates, thus enabling the building society movement to become more fully integrated in to the financial services sector as a whole. Nevertheless, as Thompson (1997) notes, "the financial services industry is probably unique among the principal areas of economic activity in having an extensive sector of mutual firms which coexist with - and compete against - joint stock companies on an equal basis".

## **2.5 MERGERS, ACQUISITIONS AND CONVERSIONS FROM MUTUAL TO PLC STATUS**

Over the past 10 years the UK building society industry has undergone perhaps the most dramatic changes in its entire 220 year history. The trends in both mergers and acquisitions and conversions to Plc status during the 1990s have threatened the very existence of the building society movement and as such are addressed below. Section



2.5.1 considers the trend in friendly mergers and acquisitions between societies and discusses a number of papers which have focused on explaining the motives for such activities. Section 2.5.2 then analyses how the Building Societies Act of 1986 has encouraged an increasing number of the remaining mutual societies to opt for Plc status, abandoning their mutuality in favour of greater legislative freedom.

### **2.5.1 Merger and Acquisition Activity**

Table 2.2 below shows how the number of building societies has fallen since 1900, although it must be interpreted with care since up to 1980 some of the reduction in numbers could be attributed to terminating societies winding up their business rather than merger or acquisition activity<sup>58</sup>. Nevertheless, both the annual rate of decline in the number of societies and the proportion of assets involved in take-over activity is higher now than at any other time during the twentieth century<sup>59</sup>. The average value of mergers and amalgamations has tended to be higher than that of transfers of engagements, but the latter have generally been greater in number as one would expect given the way in which these activities are defined (see Section 2.3.1 of this chapter). Indeed, Lawrence (1995) predicts that as a result of recent and expected future mergers and conversions, the retail financial services industry will in future be dominated by between 10 and 15 national organisations offering a wide range of financial products.

The academic literature on recent building society mergers, amalgamations and transfers of business has undoubtedly been sparse. Two recent papers dealing explicitly with merger and amalgamation activity among mutual financial institutions are, however, particularly worthy of attention.

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<sup>58</sup> See Appendix 2.1 for a list of all transfers of engagements between 1980 and 1997.

<sup>59</sup> In fact, mergers were not uncommon even in the nineteenth century, although not on the scale nor at the speed of those more recent alliances.

**Table 2.2 : The Number of Building Societies, 1900 - 1998**

Year	No. of Societies	Year	No. of Societies
1900	2286	1985	167
1910	1723	1986	151
1920	1271	1987	138
1930	1026	1988	131
1940	952	1989	126
1950	819	1990	117
1960	726	1991	110
1970	481	1992	105
1980	273	1993	101
1981	253	1994	96
1982	227	1995	94
1983	206	1996	88
1984	190	1997	82
		1998	71

*Source* : Housing Finance

Thompson (1997) and Ingham and Wong (1994) have examined the process of mergers and take-overs within the UK building society sector. It is noted that despite the high rates of friendly acquisition activity, the absence of hostile take-overs means that it may be impossible to discipline management if power is abused (unlike the management of a joint stock company). Hostile take-overs are essentially impossible in the building society industry due to the lack of a secondary market in ownership claims (owner members cannot sell their claims to any accumulated surplus on a secondary market), the operation of 'one-member one-vote' rules (making ownership claims particularly diffuse and thus concerted action very weak) and regulatory restrictions (the 1986 Building Societies Act dictates that merger proposals must be endorsed by the board of the target society). Managerial probity is therefore upheld mainly by the threat of members withdrawing their business, which in the case of depositors could lead to the partial liquidation of the society<sup>60</sup>. As Thompson (1997) writes, "the costless economic action of *exit* dominates the political process of *voice*". The ease by which disenchanted members can transfer business to another society (which may better reflect their interests) and the availability of 90 per cent depositor

<sup>60</sup> In addition, since executive remuneration will likely depend on either the size of the society's retained profits, member benefits or both, management will be encouraged to maximise efficiency.



protection have both reduced the incentive to participate in the monitoring of the incumbent management.

Thompson (1997) considers three possible reasons that a society may be subject to an intra-sector non-hostile take-over :

- 'natural selection' : the elimination of under-performing societies through the transfer of assets to those societies which may be better placed to use them.
- societies that have been unsuccessful in achieving management objectives (in particular size, growth and earnings stability<sup>61</sup>) are more easily persuaded to accept a proposed merger or acquisition. In addition, incentives to accept take-over proposals have increased for those societies constrained from full diversification by the £100m asset threshold under the 1986 Building Societies Act. Although such expansion could occur through internal rather than external growth, the latter option has been more appealing as societies may not have had the internal resources to expand their management team rapidly enough. Smaller societies have also tended to have higher management expense ratios and administrative burdens; since the abandonment of the interest rate cartel in 1983, interest rate spreads are no longer generous enough to permit the survival of such societies.
- where a society has financial problems (especially liquidity concerns) the regulator may encourage its take-over by another society in order to avert losses or bankruptcy and so ensure sectoral stability (for example the Woolwich take-over of the Town and Country building society in May 1992 whose financial problems were a result of over-exposure in the South East housing market during the late 1980s<sup>62</sup>). The request to take-over a failing society by the BSC has never been mandatory, but larger societies do tend to look to the regulator for advice.

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<sup>61</sup> Evidence is mixed on profitability due to the diverse nature of building societies' objective functions.

<sup>62</sup> Ingham and Wong (1994) discuss how the risky policies undertaken by the Town and Country (including the offering of high loan to value ratios to high risk borrowers) may have contributed to the failure of its merger talks with the Leeds building society in July 1986.

Thompson's (1997) study estimates a pooled logit model over a sample of 90 per cent of all societies between 1981 and 1993 in which the probability of any society being taken over is dependent on a number of variables designed to reflect the three hypotheses outlined above. The findings of Thompson's study support both the managerial objectives hypothesis (that smaller societies or those with lower growth rates are more likely to be taken over) and also the regulatory persuasion argument (that societies with negative profits or lower levels of free reserves<sup>63</sup> are more susceptible to acquisition). However, no evidence was found to support the natural selection hypothesis, with the coefficient on profitability (profits divided by assets) being negative but insignificant<sup>64</sup>.

The conclusions were noted to be similar to other studies on joint stock companies, a result which was deemed surprising given the differences between the structure of building societies and public limited companies (however, changes in mutual behaviour over the period of estimation may be able to account for this similarity). Thompson finds that the effects of building society size in the estimations disappear after the re-regulatory legislation of 1986, as acquisitions among medium sized societies were encouraged (rather than small societies being subsumed by larger ones) to escape the diversification restrictions on asset size.

Although Thompson's work considers the motives of target societies to be acquired, it does not analyse the motives of the acquiring societies to partake in the transfer of assets. Gough (1979) and Barnes (1985) have found that little benefit accrues to the acquiring society during a take-over, a result that has also been found for publicly owned companies (it has been suggested that a reason for this is generally the acquirer's over-use of discretionary spending on the take-over). However, Jensen (1986) has observed that it may be the availability of large surpluses that governs the desire of the acquiring society to take over another given that all intra-sector

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<sup>63</sup> Free reserves are defined to be actual reserves less required reserves; the variable used in Thompson's paper was divided by the society's asset base.

<sup>64</sup> This serves to indicate that profitability is not the only building society objective; a society that redistributes all of its potential profits as preferential interest rates to its members may be no more likely to approve a take-over than any other society. Perhaps Thompson would have been better off to indicate profitability and efficiency using a combination of a managerial expense ratio, interest margins (to measure liquidity), asset growth and the society's surplus.



acquisitions must be internally financed (the 'free cash flow' theory of mergers). Finally, Ingham and Wong (1994) in their case studies of two failed intra-sector mergers suggest that a number of factors may be important to the two parties in their decision to merge : the duplication of branch networks and geographic diversification opportunities, managerial aspirations of size and growth, measures of performance and the compatibility of management, computer systems and business strategies.

### **2.5.2 Conversion from Mutual to Plc Status**

Procedures were laid down in the Building Societies Act (1986) to allow building societies to renounce their mutuality and convert to Public Limited Companies (Plcs), a power that formally became available to the societies from 1 January 1988. This involves the loss of mutual status of the converting society which would then require authorisation as a bank under the Banking Act of 1987. Since 1989, an increasing number of societies have either converted to Plc status, merged with an existing bank or have indeed done both (as with the case of the Halifax and the Leeds Building Societies, the merged institution being floated on the stock exchange during the summer of 1997; the combined group at the time of conversion held around 30 per cent of total building society assets). Table 2.3 below gives details of societies forgoing their mutual status in favour of company status via the means of either conversion, merger or take-over.

The Building Societies Acts of 1986 and 1997 have been instrumental in causing the rise of the multipurpose financial intermediary and have encouraged societies to convert to company status. As is noted by Lawrence (1995), "the traditional boundaries which separate banks, building societies and insurers are becoming increasingly blurred" as building societies during the mid-1980s, "grasped the opportunity to sell insurance on the back of strong sales of mortgages and savings products". Hamnett (1994) confirms this tendency and writes that, "there has been a trend away from specialist lending circuits of housing finance towards a system in which the commercial banks and other financial institutions compete to lend". This has happened as societies have polarised into two distinct categories :

- larger societies which consider regulations to be over-restrictive and thus desire to become broader based multipurpose financial intermediaries by converting to Plc status
- small and medium sized societies preferring to focus on traditional building society business, namely mortgages and savings.

**Table 2.3 : Building Societies Ending their Mutual Status**

Institution	Merger/ Take-over Date	Flotation Date	Announcement Date	Bid Size	Market Cap.
Abbey National	N/A	12 July 1989	March 1988	N/A	£9bn
Lloyds and Cheltenham and Gloucester	1 August 1995	N/A	April 1994	£1.8bn	£9bn
Halifax and Leeds Permanent	1 August 1995	2 June 1997	November 1994	N/A	£9.8bn
Abbey National Plc and National & Provincial	5 August 1996	N/A	July 1995	£1.35bn	N/A
Woolwich	N/A	7 July 1997	January 1996	N/A	£5.3bn
Alliance and Leicester	N/A	21 April 1997	February 1996	N/A	£2.5bn
Northern Rock	N/A	1 October 1997	April 1996	N/A	£1bn
Bank of Ireland and Bristol and West	28 July 1997	N/A	April 1996	£0.6bn	£4.6bn
Halifax and Birmingham Midshires	19 April 1999	N/A	December 1998	£0.75bn	N/A
Bradford & Bingley	N/A	Expected 2000	April 1999	N/A	£2.5bn

Take-overs/mergers: the dominant firm is indicated in bold. Conversions : institutions are indicated in normal font. N/A indicates that the data is either not available or not applicable.

However the Bristol and West, who have recently been taken over by the Bank of Ireland, have attempted to retain their traditional role whilst becoming part of a wider corporate structure. In fact their slogan remains, '*Mortgages, Savings, Investments ... And Nothing Else*'.



This polarisation has stimulated competition between the two groups of societies and has made the task of the BSA in representing their collective views more difficult as society objectives have become more diverse (see Boddy (1991)). Subsequent conversions and competitive pressures amongst the societies have thus undermined the influence of the BSA to a considerable extent.

The decision by a society to convert from mutual to company status can be thought of as depending upon a number of factors, which are discussed extensively below in the remainder of this section.

(i) Perhaps the single most important motivating factor cited by building societies in their decision to convert has been their inability to generate sufficient capital to finance the development of their business whilst remaining in the mutual sector. As mutual institutions, building societies cannot issue shares, and as such only have their reserve capital upon which to draw (which in turn is dependent upon their annual surpluses)<sup>65</sup>. On the other hand, as a public limited company, the financial institution would be obliged to service its share capital (in the way of both dividends and share price appreciation<sup>66</sup>) in contrast to the cost-free reserve capital enjoyed under mutuality. In effect, the lower cost of servicing capital allows mutuality to pay dividends in the form of lower borrowing rates and higher savings rates than could otherwise be achieved as a publicly quoted company<sup>67</sup>. Examples of such schemes include that offered by the Yorkshire Building Society, where a minimum rate is offered on all savings accounts irrespective of the credit balance, and 'loyalty-mortgages' whereby the borrower receives a discount only if they have been a member of the society for a specified number of years<sup>68</sup>. Smith (1996c) states that, "those which do not produce similar schemes for 'positive mutuality' may find themselves

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<sup>65</sup> It must be noted that building societies can raise a limited amount of subordinated debt capital (i.e. an issue of debt whose holders have a claim on the assets of the society only after members claims have been satisfied). However, this route is less favoured than the raising of equity capital due to debt service obligations.

<sup>66</sup> In fact, a higher overall required return by shareholders may necessitate a higher spread between asset and liability interest rates, which may have implications for the new company's competitive position.

<sup>67</sup> This is the premise of Chapter 5 of the thesis, in which borrowers and savers receive financial benefits from their membership of the society to the extent that the society's saving (borrowing) rates are higher (lower) than any alternative use (source) of funds.

<sup>68</sup> Equivalent 'loyalty-bonds' for savers are also offered by a number of societies.



heading the list of possible acquisitions by Plcs, because they are not seen as committed to remaining mutual". Whether such schemes can be maintained in the long term, given the increasing intensity of competition as more and more societies renounce their mutuality is, however, questionable.

(ii) Related to the above argument, the freedom of banks to operate under a less restricted legislative framework than their mutual counterparts has also been particularly important in the decisions of societies to convert. Building societies are regulated in accordance with the Building Societies Acts of 1986 and 1997 whereas the banking sector is regulated by the Banking Act of 1987. The Building Societies Act of 1986 represented the first stage of convergence of the two regulatory frameworks, which along with substantial changes in the financial system has fuelled the desire for building societies to convert to Plc status. Despite the fact that the Building Societies Act of 1997 has gone one step further by lifting a number of additional restrictions on societies' business, the ultimate goal of regulatory harmonisation is still a long way off and the gulf between the legislative frameworks under which banks and building societies operate is still significantly wide enough to encourage de-mutualisation. Specifically, on the asset side societies have been restricted to channelling a large majority of their funds into mortgage lending (see Table 2.1 above) whilst on the liability side, they have been denied full access to the range of alternative sources of funding long enjoyed by the banking sector. As such, building societies were simultaneously exposed to the risks of rising retail deposit rates (especially in a world of heightened deposit inflow volatility - see Figure 2.4 above), a slowdown in the housing market and increased competition in the provision of mortgage finance, all of which were characteristic of the early 1990s. It is hardly surprising, therefore, that a significant number of building societies made their plans to convert during the early to mid-1990s.

This argument may prove especially important for those smaller societies whose exclusion from certain types of particularly lucrative asset business has considerably intensified such problems. Moreover, Marshall *et al* (1997) argue that since the departure of larger building societies from the movement will lead to further increases



in competitiveness in the market for financial products (including mortgages), those smaller societies remaining mutual may find it less easy to withstand bad risks. For fear of the onset of a financial crisis among the remaining societies, it is suggested that the Financial Services Authority may be encouraged to interpret existing building society regulation more rigorously, inducing further conversions from mutual to Plc status. Thus it is of no surprise that following the announcements of some of the larger societies to abandon their mutual status, there has been widespread speculation that some of the smaller societies may be subject to take-over bids given their particular susceptibility<sup>69</sup>.

A final point to note on the regulatory side is that the Building Societies Act of 1986 precluded any hostile take-over bid during the first 5 years of operation of the converted society<sup>70</sup>, which should clearly act to encourage de-mutualisation. In addition, this limited period of grace may stimulate efficiency in the newly floated company; as the Lex Column of the Financial Times (1996) writes, "if they have not achieved critical mass by then [5 years after the flotation], they will be sitting ducks".

(iii) It has been alleged that a positive aspect of conversion is that investors will gain a share of the society's reserves in the form of a windfall cash bonus on conversion. This can be seen as a fallacious argument for two reasons. Firstly, any such reserve payouts will undoubtedly be diluted to the extent that new members join the society purely for speculative reasons. Secondly, the argument breaks down due to the 'bird-in-the-hand' fallacy; by receiving cash bonuses, investors and borrowers in aggregate will be no better off than they would have been had they received the distribution in the form of increased savings rates or lower mortgage rates. In fact, the costs of conversion will mean that benefits accruing to members in the form of cash bonuses may be *less than* those arising from the adoption of favourable interest rates under mutuality. Nevertheless, the benefits of conversion are all apparent to the society's members and thus conversion is likely to be favoured over mutuality.

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<sup>69</sup> Indeed, some have argued that the motivation of the lesser sized societies to renounce their mutuality in favour of share ownership (examples include Northern Rock and the Alliance and Leicester) has been to avoid the possibility of a future contested take-over bid.

<sup>70</sup> This is the case unless at least 75 per cent of its shareholders vote to remove protection or the newly converted society acquires a financial services institution during that time.



Indeed, the precedent for a cash or share distribution on the conversion of a society has now been set, making the whole process of becoming a Plc more expensive for the institution involved. Lawrence (1995) writes that, "the higher stakes will make it harder for the directors of building societies to persuade members that it is in their interest to give up their membership rights unless they realise some significant value from it". Building societies that have thus far decided to remain mutual (examples include the Nationwide, Skipton and Britannia) have been subject to considerable speculation that they may either convert or merge with a rival society. It is noted by Marshall *et al* (1997) that the latter is a more risky strategy given that the merger announcement may encourage a non-mutual financial institution (with access to considerably more funds) to make a more lucrative offer for the society, thus removing it from the mutual sector. The remaining mutual societies have attempted to detract potential speculation by cutting their margins (i.e., lowering their mortgage rate and raising their deposit rate) and making 'pro-mutual' statements. The Nationwide, Britannia and Yorkshire building societies (among others) have even gone as far as to require that any new members (as of 2 November 1997 and 8 April 1998 for the first two respectively) donate any benefits they may receive if the society were to convert to company status to a charity set up by the society if the conversion were to take place within five years of becoming a member. Clearly, the modification of the 1986 Act to avoid speculative inflows into societies by requiring depositors to have held investment accounts for at least two years to qualify for compensation has not had its desired effect.

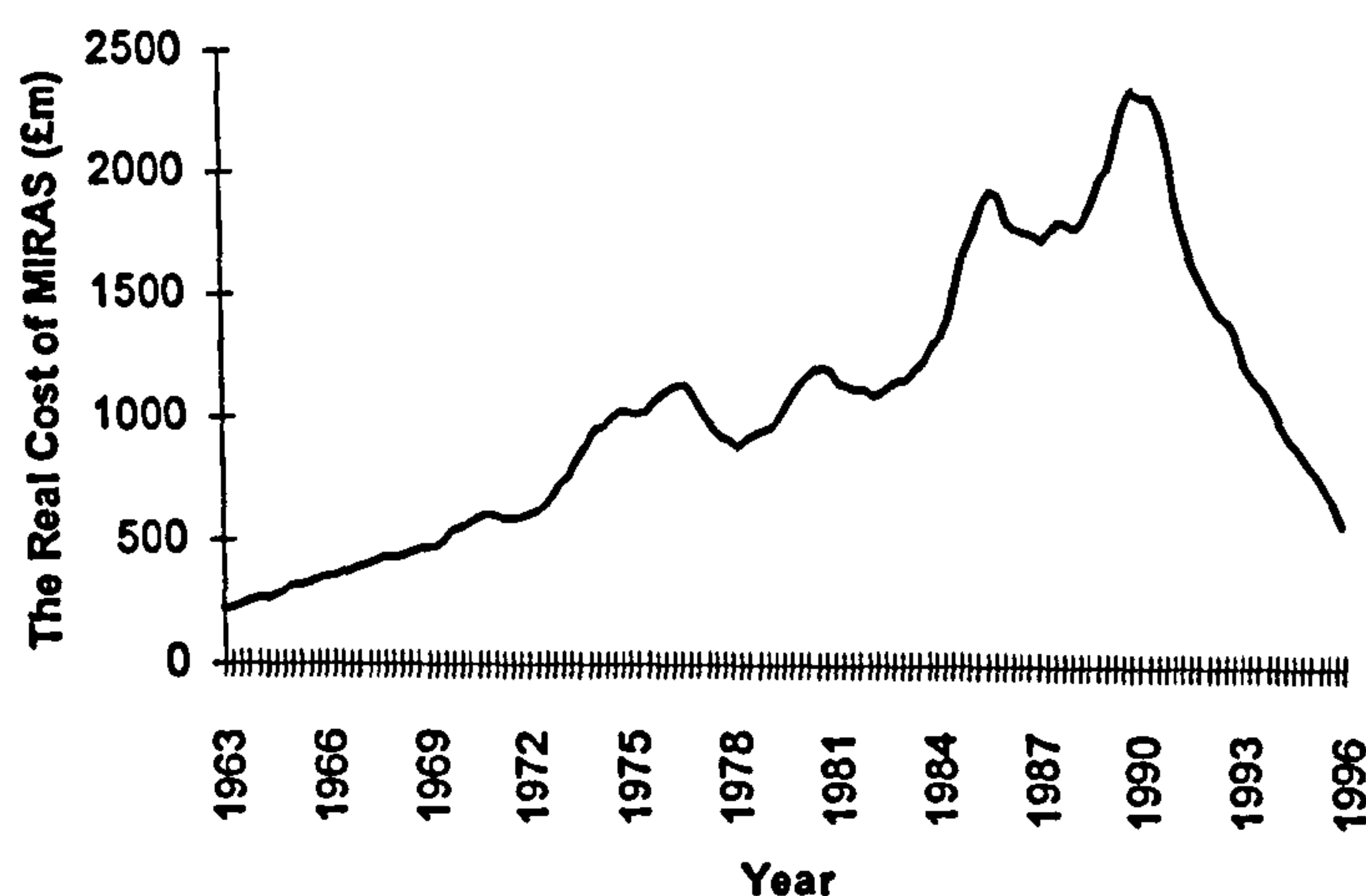
Of course, this has led to a considerable amount of speculative deposits being 'locked-in' to those building societies converting to Plc status; funds have become less mobile as depositors await their bonus payout (the Halifax conversion, for example, took two and a half years to complete). This has allowed converting societies to pay a lower rate of interest on retail funds than the market would normally require although newly converted societies may find it difficult to keep such funds after flotation is completed without substantial increases in their deposit interest rate.



(iv) Following a rise in competition among mortgage providers, the spate of recent conversions and mergers in the housing finance industry has suggested that there may be over-supply in the mortgage market. This excess capacity has occurred as a reduction in housing market transactions has significantly reduced the demand for mortgages whilst increased competition between lenders has acted to increase mortgage supply.

The downturn in the housing market during the early 1990s essentially resulted from a higher perceived risk involved in the purchase of a house (as a result of dramatic interest rate rises and the onset of recession). Marshall *et al* (1997) suggest that low inflation reduced the demand for housing as potential buyers could no longer rely on either increases in income to ease the burden of mortgage payments<sup>71</sup> or the prospect of capital gains on the housing asset. In addition, the labour market deteriorated rapidly during the recession of the early 1990s accompanied by a fall in job tenure, both of which operated to restrict the demand for mortgage finance.

**Figure 2.11 : The Real Cost of MIRAS and the Option Mortgage Scheme (OMS) to the Government at 1995 Prices (per quarter)**



Source : Inland Revenue Statistics

<sup>71</sup> It is important to note that this view of the effect of inflation on mortgage demand is contrary to that presented in Chapter 3 of the thesis, in which the 'tilt' effect of higher inflation is seen as a deterrent to households taking on long term debt.

Another important factor influencing the weakening of the mortgage market during this period was the increase in the debt burden of mortgage holders resulting from changes to government policy. The real value of MIRAS, for example, has declined significantly during the 1990s as illustrated in Figure 2.11 above. Finally, demand had been depressed by a decline in the number of first time buyers resulting from the fall in the birth rate during the early 1970s.

This market contraction further encouraged competitive pricing in the industry and thus required dramatic rationalisation to reduce costs in order that margins may be defended, with all converting societies announcing plans to do as such (Leyshon and Thrift (1993) refer to this rationalisation as 'restructuring for profit'). This has involved making more productive use of staff which in turn has led to job cuts in the building society sector. As is discussed in the Lex column of the Financial Times (1996), "with core markets stagnant, financial services businesses need to boost earnings by cutting costs - which is much easier through consolidation. Medium-sized societies ... face a tough fight for independence". The Halifax, for example, announced a year prior to its flotation that it would be cutting staff in its process of rationalisation, although new jobs were to be created as a result of product diversification (most notably in telephone banking and insurance). In addition, some *mutuals* announced plans to rationalise their cost structure (for example Bradford and Bingley prior to its decision to float). It is suggested that societies can more easily engage in this new rationalisation occurring throughout the financial services industry if they become Plcs rather than remain in the mutual sector since corporate status can offer them the ability to diversify in a financial market characterised by an over-supply of mortgages. Related to this argument is the fact that becoming a Plc means that the management must be more accountable to its shareholders which could be expected to encourage the process of rationalisation even further. Cost cutting rationalisation is expected to lead to, "a scaling back of the high street representation of financial organisations" (Smith (1996a)).

Indeed, Drake (1989) points out that in increasing their size of operation through demutualisation, societies have been able to benefit from significant economies of scale.



It is generally agreed in the literature that economies of scale in the building society industry have primarily operated through the more efficient use of capital and lower average operating and funding costs. In addition, geographical economies have also played an important role given that many of the remaining societies are regionally based<sup>72</sup>.

Nevertheless, one must not lose sight of the fact that some costs will undoubtedly rise for newly converted societies. Specifically, de-mutualisation has tended to be associated with *increased* management costs to the extent that the new company must serve its shareholders and is required to provide more comprehensive financial reports. As Lawrence (1995) writes, conversion will, “put the organisation and its directors under the microscope of reporting that goes with public ownership”. In addition, the diversification of activities into new and growing business (which has inevitably occurred following conversions) means that expenses may be harder to control. It is also argued that it is the culture of ‘new mutuality’ (referring to remaining mutual societies becoming more staunchly protective of their mutual status) rather than *de-mutualisation* that encourages greater accountability.

As we have seen above, there are a number of significant and permanent benefits that may be achieved by building societies (and indeed their members/shareholders) from de-mutualisation. Nevertheless, there are non-trivial costs involved in the process of conversion, but these tend to be short-lived and are generally outweighed by the long run financial gains. As such, in the current regulatory climate one would be hard-pushed to argue the case for mutuality.

## 2.6 SUMMARY AND CONCLUSIONS

This chapter has examined the nature of the mortgage market in the UK from its beginnings in the eighteenth century up until the present day. Attention is focused on the more recent developments in the market that have occurred since 1970 and

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<sup>72</sup> Ingham and Wong (1994) point out that (failed) merger talks between the Leeds building society and the Town and Country in 1986 were largely based on the benefits of geographic diversification, with the power base of the former being in the North of England and the latter in the South.

particularly during the 1980s and 1990s. A number of competing theories of how the mortgage market interacts with the economy as a whole were addressed in Section 2.2, with the consensus emerging that both the housing and mortgage markets have generally exhibited pro-cyclical rather than counter-cyclical behaviour.

Against the historical background of the evolution of the market for mortgage finance, Section 2.3 analysed the development of the mortgage market post 1970. The reasons for the domination of building societies over any other form of financial institution in the market prior to the 1980s is discussed, following which we turn to the legislative changes during the 1980s and 1990s and the way in which they have acted to alter the balance between (most notably) bank and building society mortgage lending. Since 1980 the market has moved from one characterised by considerable mortgage rationing in which mortgage and deposit rates were set collectively to the present day situation in which both banks and building societies compete vigorously against each other in order to maintain market share.

The legislation under which building societies (and banks) operate in the mortgage market was considered in Section 2.4, acting as a precursor to an analysis of the trends in mergers, amalgamations and conversions within the mutual sector. Over the 220 years of building society operations, up until only recently (1989) they have managed to retain their mutuality whilst undergoing dramatic changes in their financial structure. They have evolved from relatively unconnected groups of individuals to become major players as financial intermediaries with their present balance sheet structure being shaped by a combination of both practical experience and numerous changes in the legislative framework which have governed their operation. However, with competition across the spectrum of financial services becoming more intense, the restrictive nature of building society legislation would suggest a short future for mutual financial institutions. Unless further regulatory efforts are made to create a more level playing field, the trend in de-mutualisation is unlikely to cease.



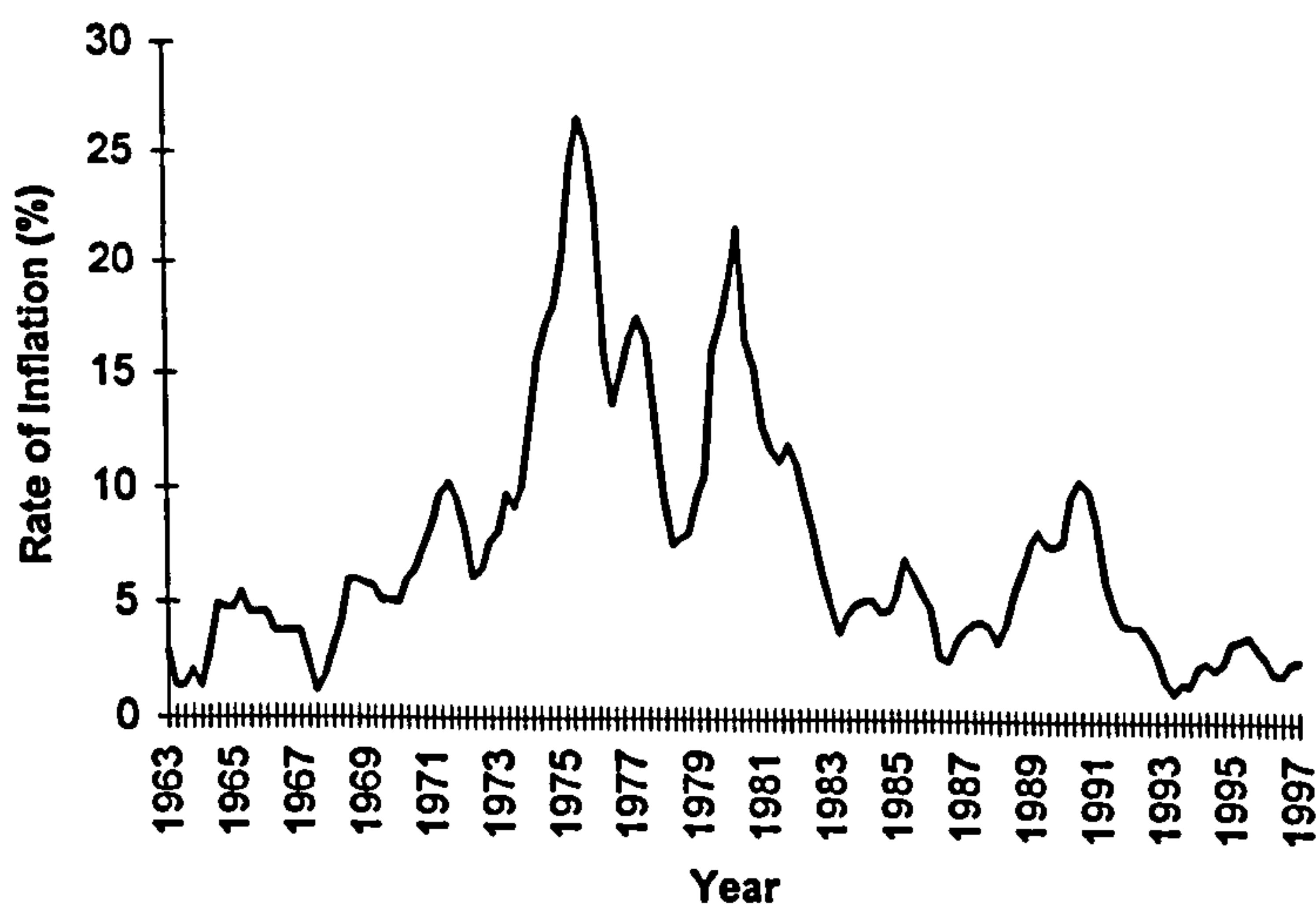
## CHAPTER 3

### The Effect of General Price Inflation on Long Term Mortgage Finance

#### 3.1 INTRODUCTION

During the past 25 years, the UK has witnessed periods of high and volatile rates of inflation. In contrast to the periods of relative general price level stability observed during the 1950s and 1960s, extraordinarily high rates of inflation were experienced throughout the 1970s (and into the early 1980s) reaching a peak of 26.5 per cent in the third quarter of 1975. However, after reaching a local peak of 21.5 per cent in the second quarter of 1980, the rate of inflation fell sharply as a result of the tighter monetary policies of the new Conservative government.

Figure 3.1 : The Rate of Inflation, 1963-1997



In addition to the important implications of general price inflation *per se*, through its effect on nominal interest rates inflation has adverse effects on all sectors of the economy, and none more so than on that of housing. In fact, it is generally agreed that especially high, variable and unpredictable inflation and nominal interest rates have led to considerable turbulence in the housing and mortgage markets. Nevertheless, it

will be seen in this chapter that even a moderate level of inflation which is fully anticipated can cause serious financing problems for borrowers in the market for mortgage finance.

This chapter is organised as follows. The distortions caused by inflation in the market for finance in general are considered in Section 3.2, which is intended to serve as an introduction to the more specific problems that arise when dealing with long term mortgage finance. This is the subject matter of Section 3.3, where the 'front-loading' or 'tilting' of real mortgage payments towards the initial years of the loan as a result of general price inflation is explored. Of course, this increase in real mortgage payments during the initial years of the loan will have the effect of increasing the likelihood of default (which is the central theme of the following chapter) and, *ceteris paribus*, reducing mortgage demand (which is explored in Chapters 6 and 7). Section 3.4 then goes on to show that in the presence of inflation it is the shortcomings of the traditional mortgage instrument that are the cause of the tilt problem, and as such the effectiveness of a number of alternative mortgage designs are reviewed as a means to mitigating or even eliminating the problem. Finally, Section 3.5 presents the summary and conclusions.

### 3.2 THE GENERAL DISTORTIONS CAUSED BY INFLATION

In order that the real value of any asset or contract may be maintained during periods in which there is a non-zero rate of inflation, there must be an equivalent change in the nominal value of such transactions. In the market for credit, for example, if the adjustment in the nominal rate of interest which results from a change in the actual or expected inflation rate is allowed to be undertaken freely, then one would expect there to be fewer real distortions in the market than if controls were imposed on attempts to adjust contracts for inflation.

The terms of a contract specifying loan arrangements which are made in advance will take into account the rate of inflation expected during that contract period. However, from past experience, when the general price level has been volatile expectations of



future inflation have tended to be unreliable and financial contracts (especially those specified over long periods of time such as mortgage loans) have become more problematic to agree, the reasons for which are twofold. Firstly, if actual future inflation exceeds (falls short of) expectations, then creditors will lose (gain) and debtors gain (lose). Assuming that all available information at the beginning of the contract period is used to forecast the rate of inflation over the duration of the loan, the difference between the predicted and actual rates of inflation should be randomly distributed with a mean of zero; therefore, the gains and losses to borrowers and savers as a result of unexpected inflation should be entirely arbitrary in nature. Secondly, not only may creditors and debtors hold differing expectations as to the future path of inflation, but they may also attach a different level of importance to the perceived gains or losses which they would face given unexpected inflation<sup>1</sup>. Therefore, the higher is the rate of inflation, the lower will be the level of lending activity as financial contracts will require more regular renegotiation involving additional (and perhaps prohibitive) costs. This turns out to be important when we consider later in the chapter a number of alternative mortgage designs; here, varying expectations of future interest rates will lead to different borrowers choosing various instruments to finance the purchase of their house. As Goodman (1992a) points out, for example, "ARMs [adjustable rate mortgages] give homeowners the option ... of switching from long term to short term credit (rather than postponing their purchase) when they *think* interest rates are abnormally high" [emphasis added].

With specific reference to the housing market, Kearl (1978) tests empirically the hypothesis that inflation does not distort the proportional change in house prices in order to draw conclusions about the effect of inflation on the demand for housing. Using US data over the period 1963 to 1973, the relative change in house prices is estimated as a function of the excess demand for housing (assumed to capture any structural shift in the housing market) and the expected proportional change in the general price index. If the null hypothesis were true (that inflation indeed does not distort the proportional change in house prices), then it must be the case that the coefficient on the price expectation term will equal unity (i.e. house prices are

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<sup>1</sup> In addition, each income group may face a different *actual* rate of inflation to the extent that they purchase different baskets of goods.

homogenous of degree zero with respect to inflation); in fact the null hypothesis is rejected, suggesting that expected prices are not fully incorporated into house price changes (or, that inflation is not neutral with respect to the housing market)<sup>2</sup>. As we will see throughout this chapter, an important way in which such distortions enter the market for housing are through the combination of liquidity constraints and capital market imperfections, which affect the ability of the borrower to fund repayments on the mortgage loan.

Not only does inflation *per se* cause inefficiencies in the negotiation of financial contracts, but additional and important distortions in the market for finance occur when inflation is accompanied by externally imposed interest rate restrictions. One such example in the UK has been the BSA rate fixing cartel (operating up to 1983). The effects of an interest rate fixing agreement will clearly be dependent on the prevailing rate of inflation, and in the case of the BSA cartel was specified during a period of relative price stability in order to impose what Sandilands (1980) terms a “reasonable maximum” on the building societies’ mortgage portfolio returns. However, the subsequent rise in the inflation rate during the 1970s meant that the interest rate ‘ceiling’ began to bind which, as we have discussed in the previous chapter, led to a considerable degree of mortgage rationing. By encouraging mortgage borrowing to the detriment of saving, the resulting negative real rates of mortgage interest during the 1970s<sup>3</sup> had the effect of stimulating consumption (both housing and non-housing), which served only to fuel inflation and led to further distortionary effects.

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<sup>2</sup> See equation (4.7) in Section 4.2.1 of Chapter 4 for a formal proof that inflation will have the effect of raising real house prices.

<sup>3</sup> During the mid-1970s the real rate of interest on both savings and mortgages in the UK became negative for almost three years.



### 3.3 THE EFFECT OF INFLATION ON LONG TERM MORTGAGE FINANCE

#### 3.3.1 The 'Front-Loading' or 'Tilt' Problem

General price inflation causes a number of distortions in the market for mortgage finance. For example, a real estate investor may take into account the rate at which house prices appreciate relative to the rate at which general prices are rising when deciding whether or not to purchase a dwelling. However, we generally take account of such decisions by modelling the housing and mortgage markets in *constant price* terms (i.e. the *real* demand for housing and mortgages, the *real* house price and the *real* rate of mortgage interest). In the remainder of this chapter we address the problem of the 'front-loading' (or 'tilting') of the stream of real mortgage payments. It is particularly important to consider this issue separately here since in the *theoretical* models of intertemporal housing consumption and mortgage demand presented later in the thesis, it has not been possible to incorporate this effect explicitly (unlike all other distortions created by the presence of general price inflation). One would hope to glean from the remainder of this chapter an insight into the appropriate specification of the demand for mortgage finance with regard to the inclusion of variables to proxy the effect of the front loading problem<sup>4</sup>.

Under certain conditions within the market for mortgage finance, the front-loading problem is characterised by the borrower being forced to make higher real payments during the early years of the loan than under circumstances of zero inflation. The size of the initial real payment and the speed with which the real payments decline throughout term of the mortgage will then depend positively on the rate of inflation. As Lessard and Modigliani (1975) note for the US housing and mortgage markets between 1965 to 1975, "the recurrent crises which have plagued the housing industry in the last decade can be largely traced to the interaction of a rising and variable rate of inflation with two major institutional features .... [the] almost exclusive reliance on

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<sup>4</sup> One may conceivably include a combination of any two of the following three variables in the equation of the demand for mortgage finance : the nominal mortgage rate, the real mortgage rate and the rate of inflation. Including all three would result in a multicollinearity problem (since they are linked according to the Fisher equation) and the use of only one would result in the standard demand and tilt effects not being independently accounted for in the mortgage (or housing) demand equation.



the traditional fully amortised, level payment mortgage .... and overwhelming dependence for mortgage funds on thrift institutions which secure the bulk of their funds through relatively short term deposits". Thus it is especially the coexistence of high and variable rates of inflation with the conventional level payment (often called 'French') unindexed mortgage loan that leads to and exacerbates the front-loading problem.

To examine in more detail the mechanism through which the tilt effect occurs, we first note that the Fisher effect<sup>5</sup> implies that the nominal mortgage interest rate will rise by an 'inflation premium' commensurate with the level of current or expected future inflation<sup>6</sup>. Thus for any particular house value and loan to value ratio, the required annuitised payment will, in nominal terms, be higher than if inflation were zero. Nevertheless, this will not alter the *sum* of the real payments of interest and principal over the duration of the loan. In fact, the present value of the stream of annuitised payments over the life of the loan will remain the same irrespective of the rate of inflation. However, the inflation-induced increase in the nominal interest rate will affect the intertemporal distribution of the real annuitised payments. When inflation is zero, the real value of each payment will remain constant over the duration of the loan; when nominal interest rates are raised by a non-zero inflation premium, there will be, "an increase in the level of real payments in the early years of the contract with a commensurate reduction in the later years" (Lessard and Modigliani (1975)).

Following Lessard and Modigliani, these propositions may be illustrated using a simple numerical example. Imagine that the initial mortgage debt of a borrower is £50,000 with an amortisation period of 25 years based on a fixed payment of interest and principal once a year at the end of the year<sup>7</sup>. It will also be assumed that the real

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<sup>5</sup> The Fisher effect defines the relationship between the real and nominal rates of interest ( $\rho_m$  and  $r_m$  respectively) and the rate of inflation ( $\pi$ ) as  $(1 + r_m) = (1 + \rho_m)(1 + \pi)$ .

<sup>6</sup> Essentially, the rise in the nominal rate of interest occurs as a result of the lender maintaining a constant real rate of return on the mortgage portfolio.

<sup>7</sup> Although the majority of UK mortgages are variable rate mortgages, the tilt effect remains important in such circumstances as we will see later. In addition, mortgage repayments tend to be scheduled monthly rather than on an annual basis. The standard level payment mortgage instrument being amortised with annual payments is used here to illustrate the front loading problem purely for ease of exposition.



interest rate is constant at 3 per cent per year, and that the income of the borrower (with an initial level of £15,000) grows at 2 per cent per year in real terms. Table 3.1 below shows the effect of different rates of inflation on the nominal and real annual payments, the income of the borrower and the ratio of the nominal annuitised payment to nominal borrower income<sup>8</sup>.

**Table 3.1 : The Consequences of Inflation on the Intertemporal Path of Mortgage Payments (£)**

Inflationary Conditions	Year	Nominal Annual Payment	Real Annual Payment	Borrower Income	Payment to Income Ratio (%)
0% Inflation	1	2871.39	2871.39	15300.00	18.77
3% Nominal Interest Rate	5	2871.39	2871.39	16561.21	17.34
	10	2871.39	2871.39	18284.92	15.70
	15	2871.39	2871.39	20188.03	14.22
	20	2871.39	2871.39	22289.21	12.88
	25	2871.39	2871.39	24609.09	11.67
2% Inflation	1	3547.62	3478.06	15600.00	22.74
5% Nominal Interest Rate	5	3547.62	3213.19	18249.79	19.44
	10	3547.62	2910.28	22203.66	15.98
	15	3547.62	2635.93	27014.15	13.13
	20	3547.62	2387.45	32866.85	10.79
	25	3547.62	2162.38	39987.54	8.87
4% Inflation	1	4290.53	4125.51	15900.00	26.98
7% Nominal Interest Rate	5	4290.53	3526.50	20073.38	21.37
	10	4290.53	2898.53	26862.72	15.97
	15	4290.53	2382.38	35948.37	11.94
	20	4290.53	1958.14	48107.03	8.92
	25	4290.53	1609.45	64378.06	6.66
8% Inflation	1	5937.01	5497.23	16500.00	35.98
11% Nominal Interest Rate	5	5937.01	4040.63	24157.65	24.58
	10	5937.01	2749.98	38906.14	15.26
	15	5937.01	1871.59	62658.72	9.48
	20	5937.01	1273.77	100912.50	5.88
	25	5937.01	866.91	162520.60	3.65

<sup>8</sup> An illustration of how the real repayments required of the borrower will change as a result of a *variable* rate of inflation over the duration of the loan is shown in Table A3.2.1 of Appendix 3.2.

Examining Table 3.1 above, when there is zero inflation the real value of the annuitised payment will clearly remain unchanged throughout the amortisation period of the mortgage loan. The nominal annual payment of £2871.39 (denoted  $m$  below) is calculated using the formula for the present value of an annuity given by equation (A1.12) of Appendix 3.1.

$$m = \frac{M}{\left[1 - (1 + r_m)^{-n}\right] / r_m} \quad (3.1)$$

where  $M$  is the amount of the mortgage loan,  $r_m$  is the nominal mortgage rate of interest per period and  $n$  is the number of annuity payments. With zero inflation, the annual mortgage payments represent almost 19 per cent of the borrower's income in the first year falling to 11.67 per cent in terminal year of the contract.

The remaining three cases illustrate how a positive fully anticipated rate of inflation affects the real and nominal annual payments, borrower income and the payment to income ratio. As the inflation rate rises to 2, 4 and 8 per cent, the mortgage rate is raised by an equivalent amount<sup>9</sup> and the nominal annual payments increase by 23.6, 49.4 and 106.8 per cent respectively over that of the zero inflation case. This rise in the nominal annuitised payments occurs in order to offset the decline in the real value of each payment over the length of the loan (see column of Table 3.1 entitled 'Real Annual Payment', calculated as  $R(m) = m / (1 + \pi)^t$ , where  $\pi$  is the constant rate of inflation and  $t$  is the point in time at which the real value is calculated).

Focusing specifically on the second case in which there is a constant and fully anticipated rate of inflation of 2 per cent (implying a nominal interest rate of 5 per cent given that the real rate of interest remains constant at 3 per cent), the real annuitised payments will decline at a rate of approximately 2 per cent per year, i.e. approximately at the rate of inflation. To recapitulate, therefore, if we were to assume zero inflation then real mortgage payments will remain constant throughout the life of

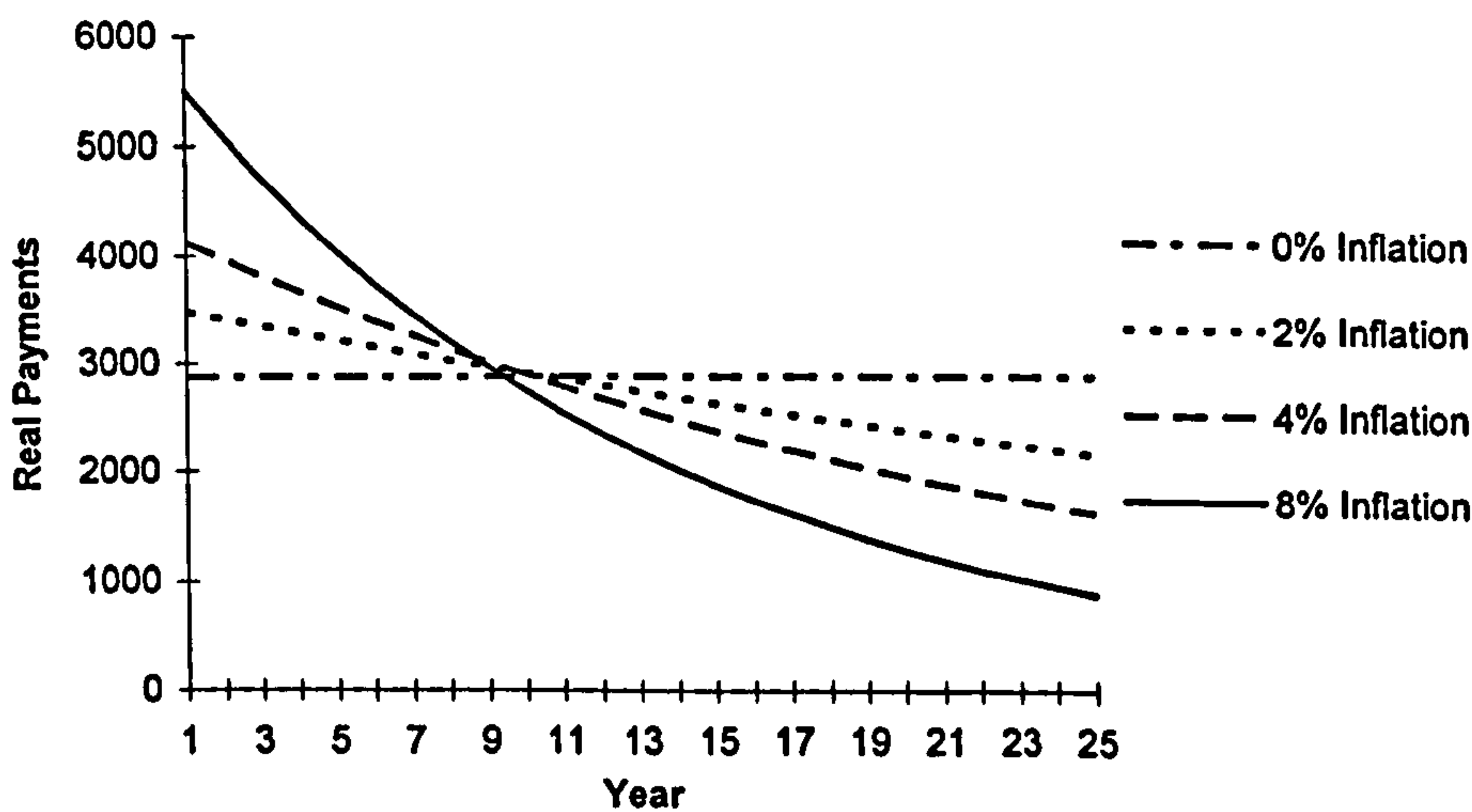
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<sup>9</sup> For simplicity, the nominal rate of interest is taken to be the sum of the real interest rate and the rate of inflation, which is a reasonable approximation to the Fisher equation.



the loan, whereas with a non-zero rate of inflation real payments in the initial years of the loan will begin higher and decline to a lower level than that of the zero inflation case. In the example given above, when the inflation rate is 8 per cent the initial real payment will be almost twice the zero inflation level and the final real payment will represent less than one sixth of its initial value (or slightly above 30 per cent of the zero inflation level).

**Figure 3.2 : The Behaviour of Real Mortgage Payments for Differing Rates of Inflation (£)**



Both Table 3.1 and Figure 3.2 above indicate clearly that the tilting of real payments towards the beginning of the loan and away from the final years of the mortgage contract is made significantly more pronounced the greater is the inflation rate<sup>10</sup>. It is important to recognise also that under the standard level payment mortgage it is not simply the *current* rate of inflation that is the cause of the front loading effect. Indeed, given a positive *expected* future rate of inflation, even when current inflation is zero the mortgage lender will want to raise nominal interest rates by an inflation premium to cover the expected rise in the future cost of funds.

<sup>10</sup> Additionally, with a higher rate of inflation the build up of housing equity will be more rapid during the early years of the loan.

To elaborate, the use of the standard level payment mortgage ensures that the risk of inflation turning out to be greater than expected lies wholly with the lender. In taking account of the rate of inflation expected during the period of the mortgage contract, Scott *et al* (1993) note that the inflation premium will lead to a higher initial debt burden and, “an affordability problem in periods of high and volatile inflation” acting to deter especially those younger borrowers from the mortgage market.

The example above suggests that the burden of a mortgage loan to a householder is related as much to the schedule of real payments as it is to the total interest cost. For the borrower, there is thus a considerable difference between paying 3 per cent interest on the given initial debt over the 25 year amortisation period with no inflation and paying 7 per cent interest on the same debt and over the same period when the annual rate of inflation stands at 4 per cent. During the early years of the debt, a mortgage loan with a high nominal interest rate will carry with it a substantially greater real burden than one with the same real but lower nominal interest rate. Thus for a given real interest rate, a higher rate of inflation will raise the nominal mortgage interest rate by a commensurate amount and will increase the initial mortgage debt burden. The real value of the borrowers debt service payments will then decline more rapidly in subsequent years, eventually falling below the constant real payment observed in a non-inflationary environment. However, it is important to reiterate that the present value of the stream of mortgage payments will remain the same whether the situation is one of fully anticipated or zero inflation; it is only the *timing* of real payments that is subject to change.

### **3.3.2 Front-Loading and the Demand for Mortgage Finance and Housing**

It has been described above how the incidence of general price inflation may act so as to ‘tilt’ the stream of real mortgage payments towards the initial years of the loan and away from the terminal years. There are two important effects which result from the problem of front-loading. Firstly, if the increase in inflation is not anticipated then those borrowers who have already purchased a dwelling with a mortgage loan (and indeed those who continue to demand mortgage finance) will be more likely to default



on the loan than they would in the absence of unexpected inflation since they will face an unforeseen fall in their real disposable income and an unexpected rise in the payment to income ratio (see Chapter 4 for a discussion of the effect of the tilt problem on the recent trends in mortgage arrears and possessions in the housing market). Secondly, with (potential) borrowers facing greater difficulty in servicing the debt in the initial years of the loan when inflation is high, the demand for long term mortgage finance and thus also the demand for owner occupied housing will be reduced as households either purchase a lower quantity or quality of housing or even postpone their decision to buy<sup>11</sup>. However, the demand for mortgages (and thus housing) will be reduced only for those households who have insufficient finances to satisfy the schedule of increased real payments during the initial years of the loan. Moreover, this is only true when financial markets are imperfect, since with perfect capital markets, borrowers would face no constraint in raising additional finance to fund the initial higher real payments (based on their future rising real income stream as collateral)<sup>12</sup>. However, as Scott *et al* (1993) point out, "home buyers are unable to take advantage of expected increases in future incomes when attempting to qualify for the relatively high fixed payments of the FRM [fixed rate or 'level payment' mortgage]". Indeed, it is generally the case that financial intermediaries will not make unsecured personal loans to borrowers for the purpose of repaying loan interest; assuming that there has not been sufficient time for the accumulation of unwithdrawn equity in the housing asset, nor will second mortgages normally be authorised. In addition, lenders in the past have tended not to make allowances for inflation-induced higher real payments by lengthening the maturity of the mortgage loan or increasing the loan to value ratio.

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<sup>11</sup> Mortgage default carries with it a cost (see Brookes, Dicks and Pradhan (1994)) and thus the higher is the probability of default, the higher will be the expected user cost of owner occupation and the lower the demand for housing. In future work in modelling the demand for housing and mortgage finance it may prove informative to incorporate a measure of the expected cost to the borrower of mortgage arrears and possession in the expression for the user cost (see Chapter 4 for a discussion).

<sup>12</sup> As Hendershott and Hu (1981) note, "the unaffordability argument pertains to a perceived disequilibrium where inflation induced financial constraints hold effective housing demand below the equilibrium level". The reason for this is that initial repayments take a larger portion of household income when inflation is high, forcing households to substitute between housing, current and future consumption (where possible) and savings.



Despite the fact that both of these latter two measures would go some way to mitigating the higher initial real payments resulting from inflation, the former could accommodate only a very moderate rate of inflation and would be achieved at the expense of increasing the *cumulative* interest burden. In addition, any rise in the loan to value ratio would increase the moral hazard risk borne by the lender during the early years of the contract. In fact, a number of studies have found that lengthening maturity or raising the loan to value ratio have only a limited effect on the demand for mortgage credit and also on the number of housing starts.

Not only will higher inflation influence borrowers to *choose* to take on lower levels of mortgage debt (and therefore consume fewer housing services) but will also cause an increase in borrowers' payment to income ratios (see final column of Table 3.1) thereby increasing the likelihood that potential mortgagors will be constrained by the prudential criteria of the lending institution (lower income borrowers may therefore be priced out of the market). As Alm and Follain (1984) note, "these liquidity constraints create a mismatch between the time sequence of mortgage payments and income" which, "reduces the number of borrowers who qualify for financing and that limits the value of the house purchased by those who do obtain financing".

Additionally, the mortgage lender may limit the size of the mortgage in order to maintain a desired payment to income ratio during the initial years of the mortgage contract, implying the value of housing that may be acquired is limited by the borrowers initial income to a considerable extent<sup>13</sup>. In fact, it is stated by Sandilands (1980) that, "with relatively moderate rates of inflation .... positive *real* rates of interest cannot be imposed on long term debts without seriously curtailing demand for funds since it is unusual for lending institutions to allow borrowers' initial debt service payments to exceed about 30 per cent of income". A rise in the borrower's payment to income ratio due to higher inflation or a reduction in the initial payment to income constraint implies that where the ratio in the first year for a mortgage of certain size exceeds the specified maximum, a smaller mortgage must be issued resulting in a larger downpayment being required of the borrower for any particular

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<sup>13</sup> Although mortgage lenders do occasionally restrict the payment to income ratio, it is more usual to specify prudential rationing criteria in terms of the loan to value and loan to income ratios.



house value. This tends to discourage mortgage borrowing and serves again to either scale down housing demand or prolong the purchase until the household has accumulated sufficient additional assets to meet the enlarged downpayment.

**Figure 3.3 : The Behaviour of the Payment-to-Income Ratio Under Differing Rates of Inflation**

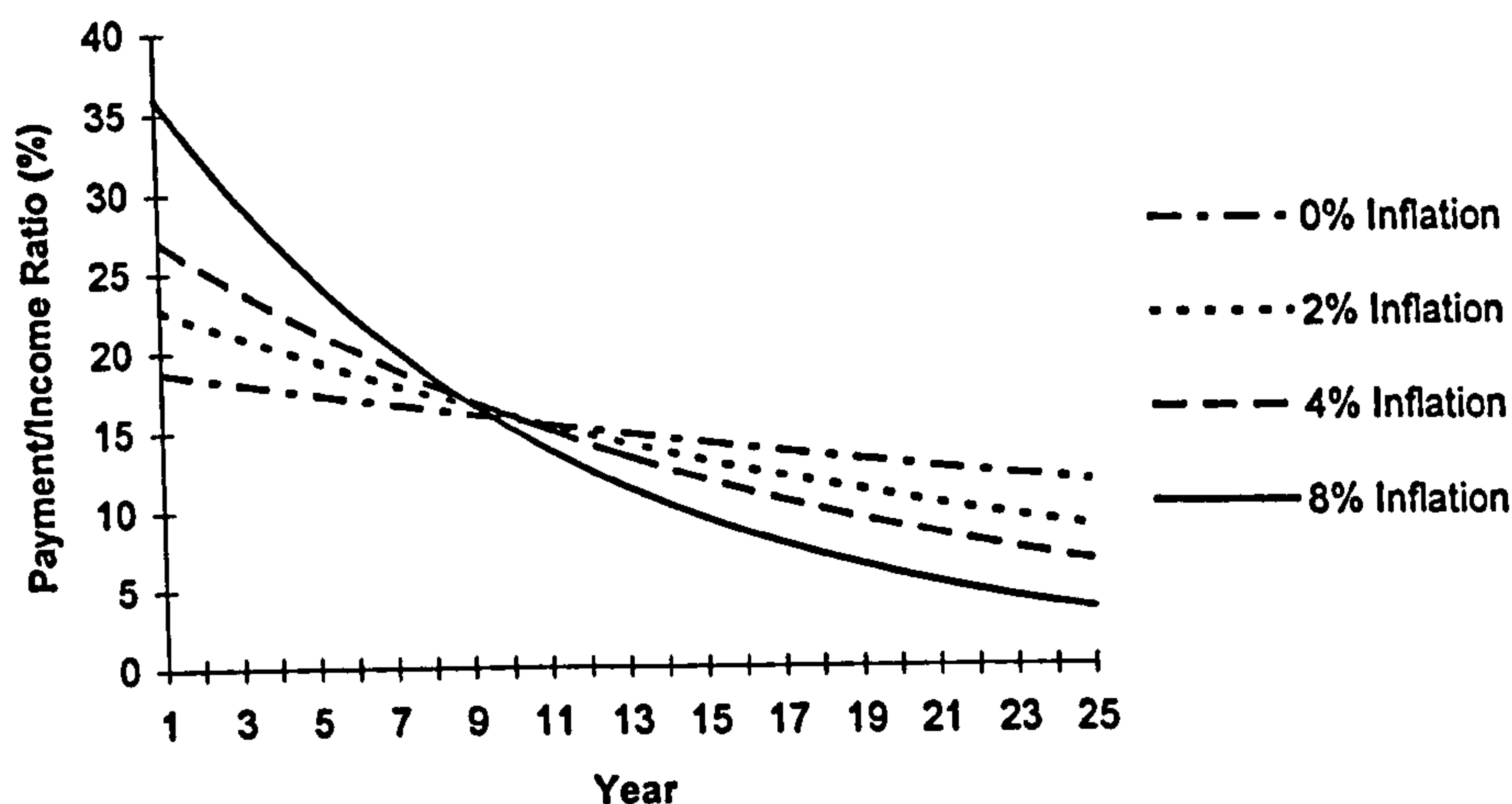


Figure 3.3 above shows the behaviour of the payment to income ratio over time in a world of inflation under the circumstances described in the previous numerical example. We saw in Table 3.1 that if inflation rose from 2 per cent to 8 per cent, the proportion of a borrower's income consumed by mortgage debt service for the first annuitised payment would increase from around 23 per cent to 36 per cent despite the fact that the real interest rate remained unchanged at 3 per cent. It may also be observed that the higher is inflation the more significant will be the fall in the ratio of the annual nominal payment to income ratio over the life of the loan. The reason for this is that an increase in the fully anticipated rate of inflation will affect mortgage payments immediately, whereas borrower income is only affected over time. It is also worth noting that even in the absence of inflation, the ratio will decline as a direct result of the assumption that nominal income increases over time according to some predetermined rule; nevertheless, through higher inflation the tilt effect will exacerbate this decline (see Figure 3.3 above). The large increase in the debt service ratio during the initial years of the loan due to a rise in the inflation rate could prove

prohibitive to many potential borrowers and cause payment problems for those who take out the mortgage under the influence of money illusion.

As we discussed above, the reduced demand for mortgage finance in the presence of inflation is not only caused by higher annual real repayments but also by the effect on the borrower's ability to meet the initial downpayment constraint. In the example above, the loan to value ratio is implicitly assumed to be 100 per cent, although in the majority of cases borrowers will be required to fund a certain portion of the house purchase (the downpayment). This is important to the extent that high inflation is often associated with low or negative real returns on financial assets (the UK during the mid-1970s provides a good example) and, as Hendershott and Villani (1977) comment, "households holding financial instruments are thus not able to meet [the] higher nominal downpayment as quickly as they would have in the absence of inflation".

An additional point to note is that although this thesis will be dealing with the aggregate demand for (and supply of) mortgage finance, it is clear that the front loading problem will affect different types of households in different ways. One would expect the effect to be more substantial for households who have a strong desire for owner occupation yet rely on the availability of mortgage credit. This group tends to be made up of first time buyers (i.e. early in the life cycle) with average levels of income who desire mortgage credit based on high loan to value ratios. Alternatively, for households who have had a chance to accumulate assets (generally middle aged families further on in the life cycle) the high initial real annual repayment and payment to income ratio pose less of a burden since these can be satisfied by using savings rather than decreasing consumption; this group essentially has a greater ability to absorb higher inflation and thus higher nominal interest rates. Indeed this is true for any group of borrowers who can meet the higher real repayments through an adjustment to their existing asset portfolio rather than a reduction in their priority living expenses.



Only a limited number of studies have attempted to take into consideration the tilt effect in empirically modelling the demand for housing. Kearl (1979), for example, proposes a simple empirical model of the housing market whereby the interaction of a fixed housing stock and the demand for housing yields an equilibrium real house price equation. The tilt effect is then accounted for by the inclusion of terms representing the initial repayment on a standard fixed rate mortgage and the elasticity of the repayment stream with respect to the nominal interest rate (the 'duration'), both of which are significantly negative in the house price equation as the tilt phenomenon would suggest (the equation is estimated on US data over the period 1961 to 1973). It is suggested that through its effect on house prices, the tilt effect will reduce constructors profit margins and thereby also the production of new houses, possibly intensifying cyclical movements in the housing market. Finally, simulations confirm that real house prices would have been substantially higher if an indexed mortgage contract had been available (through its effect on demand). A similar study to that of Kearl is provided by Thom (1983) who estimates a real house price equation over the period 1971 to 1980 on Irish data. Again, the use of the duration measure for the stream of real repayments and the level of the annuitised payment appear negatively in the price equation, echoing the findings of Kearl's study for the US<sup>14</sup>.

Schwab (1982), using a more integrated approach than previous studies, presents a two period model of housing demand from which he is able to prove theoretically the non-neutrality of inflation on the demand for housing and quantify the response of demand to changes in inflation. In the model, a representative consumer is assumed to maximise intertemporal utility subject to a budget constraint and a zero non-mortgage borrowing restriction. A negative elasticity of housing demand with respect to the rate of inflation is shown, although simulations undertaken suggest that the elasticity is small at -0.2 (relative to that on the real rate of interest of -0.6) as is the welfare loss incurred by the postponement of the housing purchase. A criticism of

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<sup>14</sup> There was also found to be an inflation induced reduction of the after-tax user cost of capital given the increased tax benefits from the MIRAS scheme and the non-taxable status of capital gains on the owner's first house. In addition, Thom finds there to be a significantly negative effect of mortgage availability on the real house price.



Schwab's paper, however, has been the failure to take into account both owner occupiers *and* renters in the model.

Finally, we must not overlook the fact that the presence of inflation will have some positive effects on the demand for housing and mortgages. Firstly, the real after-tax return on housing assets tends to increase during periods of general price inflation. Given that this is not the case for financial assets, one would expect a redistribution of wealth from financial assets to real estate for those households who can afford the initial mortgage repayments in times of high inflation. The favourable taxation of interest payments on mortgage loans (albeit diminishing - see Figure 2.11 in the previous chapter) and the absence of taxation on either the implicit rent or capital gain on the housing asset up to a certain level will act to increase the underlying demand for residential real estate (or at least the demand for leveraged funds to finance such assets) particularly for higher rate taxpayers during times of inflation since the user cost of housing will be reduced. Secondly, in the presence of inflation, housing equity will be accumulated more quickly as the ratio of outstanding mortgage debt to the value of the house will fall more rapidly given the positive correlation between house prices and the index of general prices. In addition, we have already seen that in real terms the borrower will repay the mortgage at a faster pace the higher is the rate of inflation.

As a brief conclusion to this section, we may note that although inflation does not increase the sum of discounted mortgage payments, its effect on the demand for mortgage finance through the front loading phenomenon is entirely due to the way in which it alters the time profile of the real payments over the duration of the mortgage contract. The problem therefore does not arise from the fact that under inflation borrowers can no longer afford to pay the interest and amortise the mortgage debt (since higher interest rates as a result of inflation do not alter the overall real cost of owning a house<sup>15</sup>) but rather that the use of the standard level payment mortgage requires the borrower to repay the debt at, "an unreasonably fast pace" (Lessard and Modigliani (1975)). The demand for mortgage finance will therefore be different at

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<sup>15</sup> For a given real interest rate there will be no difference in the discounted sum of all future mortgage repayments at different nominal rates of interest and inflation.



various rates of inflation (and thus also nominal interest rates if the Fisher equation holds) *even with a constant real rate of interest*. That is to say, the demand for long term loanable funds will be negatively dependent not only on the real rate of interest but also on either the nominal rate of mortgage interest or the rate of inflation<sup>16</sup>. The tilt effect thus may have far reaching effects on both the housing and construction sectors as lower mortgage demand translates into a reduction in housing demand and a fall in housing starts. As Kearn, Rosen and Swan (1975) note, "the cycle in interest rates causes one in mortgage lending and home building". Nevertheless, their paper perhaps naively argues that where basic housing demand factors (such as real income, house prices, the user cost of capital etc.) will influence the long run stock of housing, the design of mortgage instruments, credit availability and all financial variables will have little effect on stock values and more effect on the short run fluctuations in housing activity.

### 3.3.2.1 The Importance of Uncertainty and Unexpected Inflation on the Demand for Mortgage Finance and Housing

It has been described above how the level of inflation is important in reducing demand for housing finance. However, not only will the demand for mortgage loans be affected by inflation but also by the *uncertainty* of future inflation. In Table 3.1, it is assumed that the rate of inflation (and thus the nominal mortgage interest rate) will remain at a constant rate (whether it be 0, 2, 4 or 8 per cent) over the entire duration of the loan. Any deviation in the actual path of inflation from its expectation will lead to a change in real repayments (since the real repayment is calculated by deflating by the actual and not the expected rate of inflation) and also the present value of their stream. As Lessard and Modigliani (1975) point out, therefore, "in the presence of significant uncertainty about the future rate of inflation, the mortgage instrument becomes a risky one for the borrower as well as the lender".

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<sup>16</sup> Not only will the nominal interest rate affect the demand for mortgage finance through its effect on the real repayment stream over the duration of the mortgage loan, but also higher nominal interest rates may encourage potential owner occupiers to delay the purchase of the house particularly if their expectations of future interest rate movements are downwards.

As discussed in Section 3.2, when the rate of inflation is high and variable, the future expectations of lenders and borrowers may diverge significantly. This is particularly true when the loan is contracted over a long period of time since there exists a greater potential for uncertainty for both parties. Over the duration of a long term mortgage contract, the possibility of future *unexpected* inflation is high; the real value of either long term savings or borrowers' liabilities then may well be changed by the actual inflationary outcome differing from that built into the initial loan contract<sup>17</sup>; this increased risk will have the effect of reducing the demand for mortgage credit and supply of savings.

On the one hand, high inflation may have the effect of raising the nominal savings rate (and the mortgage rate if it is specified simply as a mark-up over the savings rate) by an inflation premium as savers guard against the possibility that actual inflation will turn out to be greater than expected inflation.

On the other hand, the borrower of long term fixed rate funds is placed at risk from a fall in actual future inflation, which would have the effect of raising the real debt burden; the mortgagor would therefore be less willing to commit himself to high fixed nominal interest rates. This is more likely to be the case when there is a long history of inflation and where expectations of high inflation are already incorporated into nominal interest rates. Nevertheless, the fact that some mortgage contracts allow borrowers to repay their loan ahead of schedule means that the mortgagor can always withdraw from the original contract if interest rates fall, thereby mitigating to an extent the risk that actual inflation may turn out to be lower than expected (such a mortgage contract is said to contain a 'prepayment option'). The use of the option to prepay may incur a financial penalty, the severity of which may be positively dependent on the rate and variation in inflation (higher interest rates may compensate the lender for the lower risk to the borrower implied by this prepayment provision<sup>18</sup>). Looking at the empirical evidence in the UK mortgage market, high unexpected

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<sup>17</sup> Again, the widespread introduction of variable rate mortgages funded by short maturity deposits during the 1970s helped mitigate this problem. Since then, the emergence of mortgages with fixed interest rates over a pre-specified term have to an extent reintroduced the complications.

<sup>18</sup> The resulting higher interest rates brought about by the transfer of risks from borrower to lender by means of this prepayment facility would tend to intensify the problem of front-loading.



inflation during the mid-1970s and a mortgage rate maintained at an artificially low level by the Building Societies Association cartel led to real mortgage rates remaining significantly negative for considerable length of time providing a relative advantage to the long term borrower.

On balance, it may appear that the presence of high and uncertain inflation will have the effect of reducing the demand for mortgage finance as the loan becomes more risky and the expected carrying cost higher. For most borrowers, real income will be independent of the rate of inflation, implying that the debt service ratio will exhibit significant changes over time. Therefore, the possibility of the borrower facing an uncertain future stream of real repayments dependent on the possible erratic intertemporal path of inflation will thus deter households from borrowing mortgage debt to fund the purchase of a house.

However, from the investor's perspective, physical assets such as real estate often provide a better hedge against inflation than do financial assets. In fact in a number of counties, evidence has been documented of a strong correlation between the rate of growth of house prices and retail price inflation (see Meen (1990a)). This leaves us unable to state any reliable *a priori* conclusions on the effect of future inflationary uncertainty on the demand for mortgage finance and ultimately the demand for housing.

### 3.3.3 The Supply of Mortgage Finance

The effect of inflation on the supply of mortgage finance emanates primarily from its *variation* rather than from its *level*<sup>19</sup>. The reason that inflation *per se* should not influence the supply of mortgage lending is that the providers of mortgage funds (i.e. savers) are usually assumed to be influenced by the *real* rate of interest alone, i.e. the supply of mortgage funds will be the same at all levels of the nominal interest rate which yield identical real rates of interest. This implies that neither the rate of

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<sup>19</sup> Higher inflation is important in determining mortgage supply only to the extent that the equilibrium nominal interest rate may be driven above any legally or institutionally imposed maximum.

inflation nor the nominal rate of interest should play a role in the supply function for long term mortgage funds.

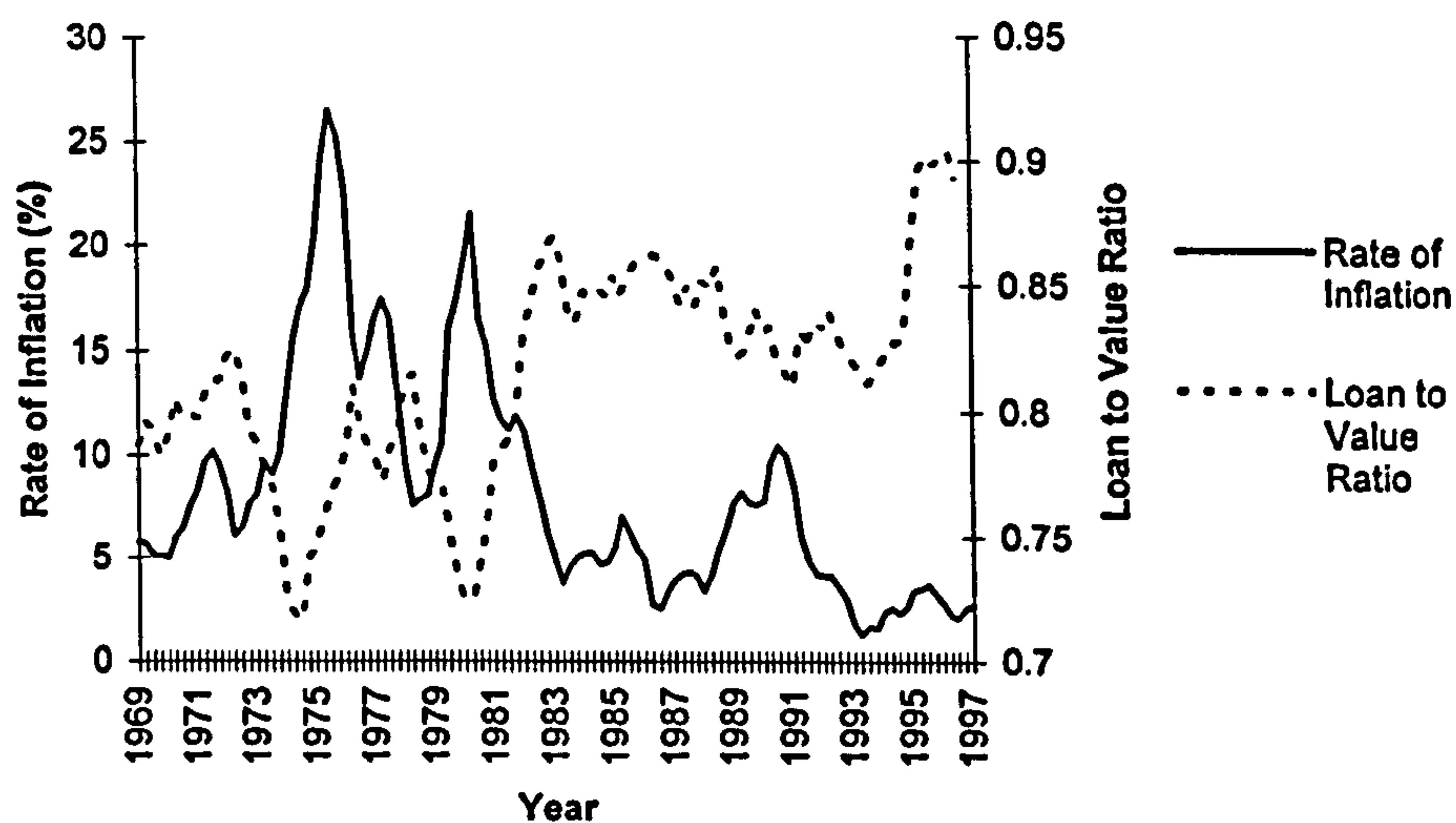
As we have seen in the previous chapter, up until the early 1980s the supply of mortgage loans was dominated by building societies, although since then banks and other financial intermediaries have successfully entered the market thereby raising the level of competition faced by the incumbent mortgage lenders. By their very nature, building societies concentrate almost exclusively on long term mortgage finance, and although there has been a growing tendency to finance their lending through longer term liabilities, it is still the case that building societies (and indeed other financial institutions lending primarily for house purchase) are to some extent maturity mismatched. That is to say, a significant proportion of their liabilities are highly liquid deposits and their assets consist predominantly of long term mortgage loans.

During the relative price stability of the 1950s and 1960s, this characteristically unbalanced portfolio was an acceptable strategy. However, with the onset of significantly higher and increasingly variable rates of inflation during the majority of the 1970s, rising interest rates made it difficult for societies to attract deposits at the rates that prevailed during the preceding period of relative price level stability. The savings rates offered by building societies became distinctly uncompetitive (relative to those offered by other financial intermediaries) since their long term fixed rate mortgage lending could not provide a sufficiently high enough income to allow more competitive rates to be paid on their deposits. Essentially, this had an identical effect to that of the imposition of a usury law on building societies alone. The difference here is that the maximum savings rate that a building society could offer was not specified by a legislative body but was instead constrained by the fixed nominal return on mortgage lending contracted by the society in the earlier period of low inflation (as recommended by the BSA agreement). The resulting failure of building societies to attract depositors during this period of high inflation, the competitiveness of their sticky mortgage rates and the subsequent lack of loanable funds is suggested by Figure 3.4 below, which serves to illustrate the strong negative correlation between the rate



of inflation and the loan to value ratio<sup>20</sup> (a proxy intended to represent the degree of rationing of mortgage finance). With high inflation and sticky mortgage rates, the relative cost of mortgage finance fell substantially during the 1970s with building societies being forced to lower the loan to value ratio in order to ration the excess demand for mortgage funds out of the market.

**Figure 3.4 : Inflation Rate versus the Loan to Value Ratio**



Again, as with the tilting of real mortgage payments, the supply side problem that materialised in the UK during the 1970s may be attributed to the use of the traditional long term mortgage instrument accompanied by a heavy dependence on very short term liabilities as a source of funds. This situation only constitutes a problem when short term nominal deposit rates rise (due to rising inflation, say) with no accompanying increase in the (fixed) long term rate earned on mortgage funds. This complication has been largely resolved by building societies supplying variable rate mortgages which, by allowing the interest rate applying to the loan throughout its life to change, enables societies to earn a return commensurate with the variable short term deposit rates. This has been the practice in the UK for a long time, although other countries have adopted different techniques (for example the financing of standard long term mortgages via liabilities of equivalent maturity such as long term

<sup>20</sup> The correlation coefficient between the two series is -0.7377.

mortgage bonds) or have been slow to take up the variable rate instrument. Nevertheless, the preference has been to make alterations to the mortgage loan contract (i.e. to shorten its effective maturity) rather than attempting to lengthen the maturity of the building society's liabilities as mortgage lenders have benefited from the ability to access the relatively cheap short term retail deposit market (particularly during periods when the yield curve has been upward sloping). As Sandilands (1980) notes, "it is often very difficult to find any savers willing to accept long term bonds except at relatively high long term interest rates". Even so, if changes to mortgage rates lag behind changes in the rate on deposits then the supply mismatching problem may not be completely eliminated<sup>21</sup>.

### **3.3.4 The Demand for and Supply of Mortgage Finance Under General Price Inflation**

In the previous two sections, demand side problems (resulting from the tilt effect) and supply side problems (due to the mismatching of asset and liability maturities) have been discussed and a number of general points have emerged regarding the implications for both demand and supply in the presence of inflation. This section (which draws on Sandilands (1980)) takes up some of these points and themes, which are incorporated into a basic but informative demand-supply analysis of mortgage funds under conditions of general price inflation. The important conclusion which will be shown here is that inflation has a non-neutral effect on the real quantity of loanable funds traded.

To recapitulate, firstly it was argued that the demand for mortgage finance should depend negatively on both the real and nominal rates of interest, the latter capturing the effect of inflation on the tilting of the real debt burden towards the beginning of the loan (thereby reducing the borrower's ability to enter the long term mortgage contract). This conclusion assumes that mortgage repayments are calculated using a mortgage instrument which does not completely insulate the borrower from the tilting

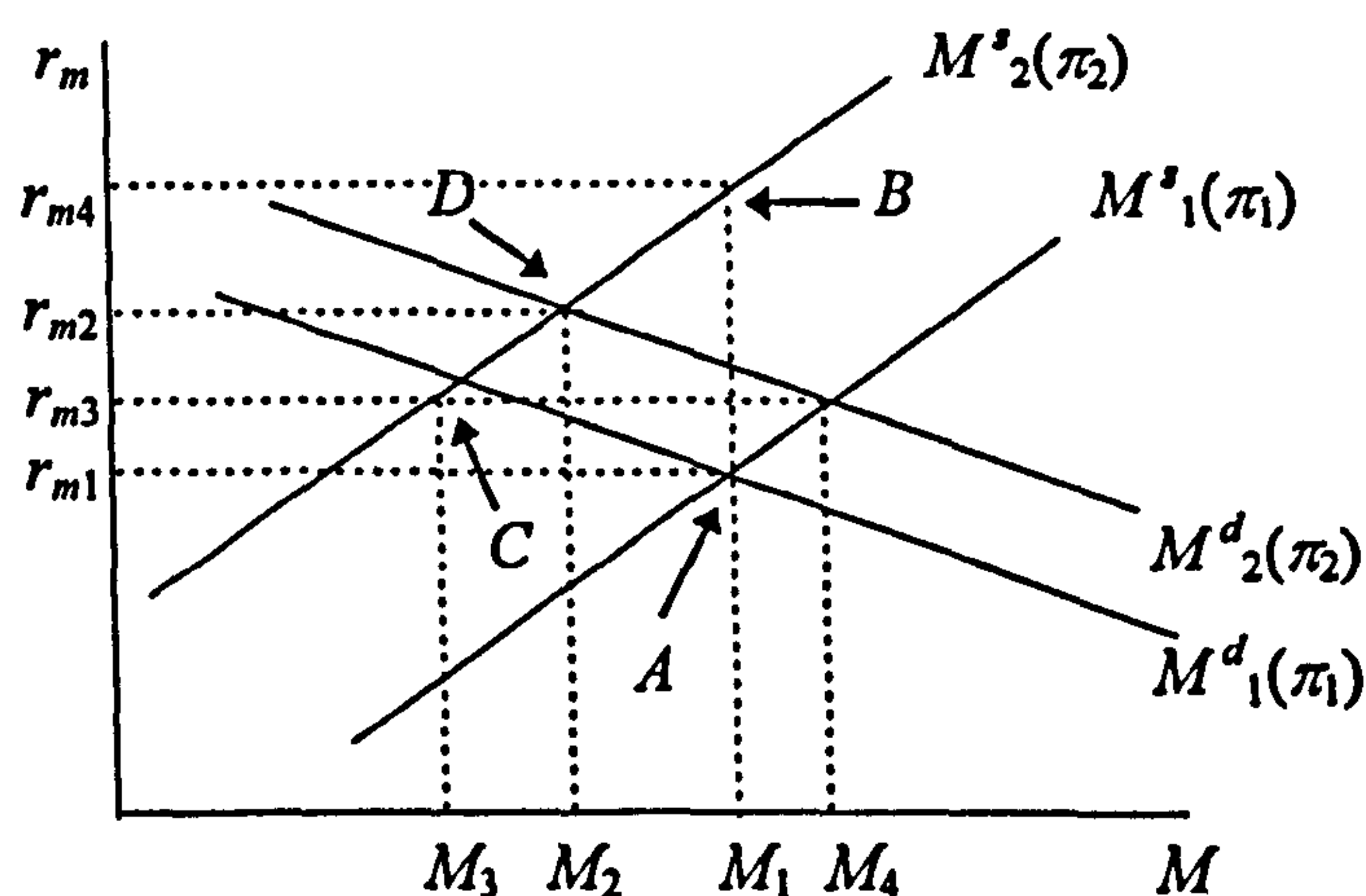
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<sup>21</sup> The recent trend in the securitisation of mortgage portfolios has removed some of the interest rate risk faced by lenders running a maturity mismatched position. Asset backed debt swaps are now commonplace in the market.



of the real repayment stream (Section 3.4 which follows considers the effects of inflation on mortgage demand when different mortgage debt instruments are used). Any change in the mortgage rate would thus be expected to have two effects on demand. Not only will there be a direct effect on the demand for mortgage credit relative to owner's equity (with the level of housing demand unchanged) but there will also be an indirect effect as the rate of mortgage interest will influence the stock demand for owner occupied dwellings. Indeed the majority of studies estimating a demand equation for owner occupied housing find a negative interest rate elasticity (see for example Meen (1990a))<sup>22</sup>. Secondly, it is assumed that the supply of mortgage funds will depend positively on the real rate of interest but will otherwise be independent of changes in the nominal rate - there is no equivalent nominal effect for the supply function as there is for demand.

**Figure 3.5 : Equilibrium in the Market for Mortgage Finance**



The interaction of the demand for and supply of loanable funds is shown in Figure 3.5 above. We begin at point A, the initial point of equilibrium at which the nominal interest rate is  $r_{m1}$  and the equilibrium volume of real lending and borrowing is  $M_1$ . The curves  $M^s_1$  and  $M^d_1$  represent the real supply of and demand for mortgage funds for a given inflation rate of  $\pi_1$ .

<sup>22</sup> However, such findings have generally not separated out the effect of the interest rate on mortgage demand and on the underlying demand for housing. As Kearn, Rosen and Swan (1975) note, "while the existing literature overwhelmingly suggests the negative impact of increases in nominal mortgage rates on the demand for starts, it is impossible to disentangle that effect into its several components".

If the rate of inflation rises to  $\pi_2$ , then for any given nominal interest rate the real rate of interest will fall. Since mortgage supply is assumed to depend only on the real rate of interest, the supply curve will shift up by the change in the rate of inflation (i.e. by  $r_{m4} - r_{m1}$ , or from  $A$  to  $B$ ) to  $M_2^s$ ; the quantity supplied at the higher rate of inflation and nominal interest rate will then be identical to the original volume supplied.

If it were the case that mortgage demand was dependent only upon the real rate of interest then, as with supply, the demand curve would shift upwards by the full amount of the increase in inflation. However, due to the tilt effect, for any given real interest rate mortgage demand will fall as the nominal interest rate rises. Thus, if the inflation rate increases, the mortgage demand function will shift up by an amount less than the change in inflation to, say,  $M_2^d$  producing a smaller equilibrium volume of funds of  $M_2$  and a lower equilibrium interest rate of  $r_{m2}$ .

The analytics are presented above for a change in the nominal interest rate whilst holding the real rate of interest constant. However, during the mid-1970s, the real mortgage rate fell sharply to -11 per cent whilst the nominal rate remained relatively stable. In this case, higher inflation actually led to an increase in the demand for mortgages since the increased rate of inflation was not fully reflected in the nominal mortgage interest rate. With real deposit rates yielding negative real returns too, this had the effect of reducing mortgage supply as savers preferred to invest in non-financial assets. This generated significant excess demand for mortgage finance as the positive effect of the fall in the real rate of interest on mortgage demand more than compensated for the negative effect of the tilt resulting from the more subdued rise in the nominal rate.

Finally, Sandilands considers the effect of a nominal interest rate ceiling on the supply of mortgage funds. An interest rate ceiling of  $r_{m3}$  (such as that generated by the building societies interest rate cartel) would cause excess demand of  $M_4 - M_3$ . If there operated a 'voluntary trading rule' in such a disequilibrium situation such as  $M = \min(M^d, M^s)$  then the imposition of the external interest rate control would further lower both the interest rate and quantity traded relative to the final equilibrium



position (i.e. point *C* relative to point *D* in Figure 3.5). This serves to confirm the content of Section 3.2 above where the distortionary effects of interference external to the market were discussed.

### 3.4 MORTGAGE INSTRUMENT DESIGN

Section 3.3 explored the mechanism through which the coexistence of inflation and the level payment mortgage can distort the demand for mortgages and introduce potential supply problems in the market for housing finance. It is the case that such problems may be mitigated or even resolved by alterations to the design of the mortgage contract, and as such, a variety of alternative contract designs are discussed below<sup>23</sup>. The level payment mortgage offering a fixed interest rate throughout its amortisation period has largely become obsolete, although many financial intermediaries have recently begun to offer mortgages that provide for fixed interest rates which are periodically renegotiated (usually every 5 years)<sup>24</sup>.

A number of innovations in mortgage design are considered in this section, and we address the extent to which each manages to either alleviate or exacerbate the problems outlined in Section 3.3 (most notably that of front-loading) and also the scope of their popularity in contemporary mortgage markets. It is hoped that this should give the reader some feel for how deeply instilled the previous concerns are within the current market for mortgage finance. This will prove to be important in assessing the effect of the front loading problem in the empirical analyses of house prices and the demand for and supply of mortgage finance presented later in the thesis.

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<sup>23</sup> Subsidies have been used in the past to hold down the mortgage rate below its equilibrium level during times of excessively high inflation in an attempt to restore the demand for mortgage finance to its zero-inflation level. However, it is recognised that this is a particularly inefficient remedy not only since households may use the low priced mortgage credit for non-durable consumption expenditure but also since the subsidy will affect all repayments over the duration of the mortgage and not just the initial high repayments.

<sup>24</sup> Such mortgages and variants thereof are known as 'rollover' mortgages.

### 3.4.1 The Variable Rate Mortgage

The standard variable rate mortgage (VRM) has proved to be an important alternative to the traditional level payment mortgage instrument in the UK since the 1970s and enjoys by far the most widespread use as the vehicle to fund the house purchase. The main feature of the VRM is that the rate of interest paid by the borrower on their outstanding mortgage debt (also known as the 'debiting rate'<sup>25</sup>) is flexible throughout the term of the mortgage contract and is set in accordance with some long term variable reference interest rate. As such, the exact future annuitised repayments will be unknown at the date of origination of the contract. The contract usually gives the lending institution the freedom to be able to choose both the reference rate to which the debiting rate is pegged (the preferred rate being that of the 3, 6 or 12 month LIBOR (London Inter-Bank Offered Rate<sup>26</sup>)) and also the frequency with which the debiting rate may be adjusted. The VRM may be further categorised into the following two types of contract.

#### 3.4.1.1 Variable Rate Instrument

With the standard variable rate VRM, a fixed amortisation period is specified in the mortgage contract with the periodic payment faced by the borrower varying in line with the debiting rate, which in turn is dependent on the relevant reference rate. For each change in the debiting rate, a stream of future constant nominal payments will be determined as if the mortgage loan were recontracted at the date of the rate change with the original maturity date remaining the same<sup>27</sup>.

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<sup>25</sup> The 'payment rate' on the other hand is the rate used in the annuity formula to compute the annual payment required of the borrower. The importance of distinguishing between these two rates will be seen later in the section. However, with the standard VRM the two rates are identical and thus may be referred to simply as the nominal interest rate.

<sup>26</sup> The choice of a standard benchmark reference rate has implications for the ease with which mortgages may be priced on the secondary market (see Section 3.5 which concludes the chapter for details).

<sup>27</sup> As previously mentioned, a combination of the standard VRM with a fixed rate element has become popular especially over the last 15 years as financial deregulation has encouraged product diversification in the mortgage market. Some VRMs provide the borrower with the option to recontract every five years or so at either a variable or fixed debiting rate of interest. However, such options are typically priced into the mortgage contract, with the borrower paying an interest rate premium to offset the lender's risk that the recontracting rate will be at a lower fixed rate than the prevailing market rate during the period.



### 3.4.1.2 Variable Maturity Instrument

In the case of a VRM of variable maturity length, a fixed periodic payment is specified for the duration of the loan contract at the outset, as is the case with the traditional level payment mortgage. However, because the contract is specified with a *variable* rate of interest, the borrower is required to repay the loan effectively at the debiting rate which will vary with the chosen reference rate. Thus if the debiting rate diverges from the initial contract rate over the duration of the loan then this must be accounted for by either extending or shortening the length of time over which the borrower makes the regular fixed repayments (depending on whether the debiting rate undergoes a net rise or fall over the mortgage duration respectively). One serious drawback of the variable maturity VRM is that even a moderate rise in the debiting rate may require there to be considerable extensions to the amortisation period. In the most severe of cases, the rate rise may render the fixed periodic payment inadequate to ever pay off the debt, with the annuity payment being insufficient even to repay the interest owed on the debt each period.

It is generally agreed that the design of the VRM has been more advantageous for the lender of mortgage funds than for the borrower. By bestowing upon the lender the ability to adjust the rate of interest on all new and existing mortgage loans at the same time as changes are made to the interest rate on its shorter term liabilities, the VRM addresses directly the problems of maturity mismatching. Essentially, the VRM allows the financial institution to establish a hedged position by reducing the effective maturity on its mortgage loans to the term of its deposit liabilities.<sup>28</sup>

However, the design of the VRM contract does nothing to alleviate the problems suffered by the borrower of long term funds, and may serve to make the position worse (if inflation rises on average during the course of the loan). The standard VRM does not remove the front loading problem since the nominal rate of interest (which depends positively on the rate of inflation) is still used in the computation of the

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<sup>28</sup> Cohn and Fischer (1975) note that the VRM does not offer a perfect hedge since although the debiting rate responds to changes in the general interest rate, it is a long term rate in contrast to deposit liability rates which are usually of a more short term nature.

periodic payment. In addition, real payments under a standard VRM will be significantly more sensitive to changes in the rate of inflation and thus also the nominal interest rate. This higher risk on the part of the mortgagor has been confirmed by a number of studies which have found that whilst borrowers have switched to VRMs to take advantage of the generally lower cost of financing, they have simultaneously reduced their housing and mortgage demand to minimise the risk of adverse changes in the mortgage interest rate. Nevertheless, such higher default risk has not been borne out by risk premiums being applied to VRMs over the interest rate of the standard level payment mortgage, nor have we seen a reduction in the willingness of the mortgage lender to loan funds; in fact in both cases the opposite has happened given the benefits of floating rate mortgages to lenders<sup>29</sup>.

We may compare the debt service ratio of the level payment and variable rate mortgages under various assumptions about the rate of inflation. Table A3.2.2 of Appendix 3.2 illustrates the way in which the stream of repayments changes as the rate of inflation varies throughout the life of a variable rate loan<sup>30</sup>. If we were to assume an initial inflation rate of 4 per cent (and an unchanging real interest rate of 3 per cent), then the calculated annual payment for the initial period of £4,290.53 for the standard level payment mortgage will be the same as that for the standard VRM and the debt service ratio in both cases will be 26.98 per cent. Suppose that following the first periodic payment the rate of inflation rises from 4 per cent to 5 per cent in year 2, giving a nominal rate of interest of 8 per cent. With a standard fixed payment mortgage the annual payment would remain constant and the debt service ratio (or payment to income ratio) would fall to  $£4,290.53 / £17,013$  or 25.22 per cent. However, with the VRM the mortgage loan is recontracted at the new nominal mortgage interest rate. The amount of debt outstanding at the beginning of the second year will be  $[£50,000 - (£4,290.53 - £3,500)] = £49,209.47$  (where £3,500 is the first year's interest payment alone) and the new annual payment for year 2 being £4,673.82.

<sup>29</sup> Other studies have found that US mortgage lenders have in general allowed households to borrow a greater amount of funds with the VRM instrument relative to the traditional fixed rate financing vehicle.

<sup>30</sup> It is proven in Section 4.2.2 of the following chapter that a rise in inflation will raise the debt service ratio.



This is calculated as

$$m = \frac{\pounds 49,209.47}{\left[ \frac{1 - (1 + 0.08)^{-24}}{0.08} \right]} \quad (3.2)$$

The payment to income ratio then rises to 27.47 per cent as a result of the discontinuous nature of changes in the periodic payment. Clearly, inflation will still cause adverse effects on the demand for mortgage finance when the VRM is used instead of the traditional level payments mortgage, and in addition the instrument will do nothing to abate the increased incidence of default which may be caused by the onset of unanticipated inflation. One way that the mortgage lender may reduce these problems for the borrower is to either choose a less volatile longer term mortgage reference rate or to limit the frequency with which changes to the debiting rate may be made. If anything, mortgage lenders have shortened the frequency of such changes with banks and building societies regularly revising their mortgage rates on the same day as the announcement by the Bank of England's Monetary Policy Committee (MPC) of a change in the repurchase rate.

Finally, one would expect that borrowers would be more likely to choose the variable rate mortgage over the level payment mortgage instrument when their income stream is expected to rise with inflation, when the initial interest rate differential between the level payment mortgage and the VRM is positive and relatively high and when interest rates are historically high. With the exception of the expectation regarding the future income stream, these hypotheses are confirmed by Dhillon *et al* (1996) and also by Jones *et al* (1995). The former paper reports the results of a probit model of the probability of VRM choice for commercial real estate projects<sup>31</sup>. The latter study uses two stage least squares to estimate both the demand and supply for VRMs in the US between 1986 and 1992. Here, demand is specified as the market share of VRMs and

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<sup>31</sup> The data set consisted of statistics on mortgage finance issued by a large US insurance company for commercial real estate projects. Although this thesis is concerned with residential mortgage demand, the study by Dhillon *et al* (1996) provides an important insight into the concerns of mortgage borrowers in choosing instrument design; commercial borrowers tend to be focused more on economic rationality in decision making than do residential borrowers, and as such the results will tend to be stronger.

the willingness to supply as the spread between the fixed level payment mortgage rate and the rate of interest on VRMs. The willingness to supply VRMs (as opposed to fixed rate mortgages) is found to depend positively on both future interest rate expectations (reflecting the desire of the lender not to be locked in to a relatively low fixed rate of interest) and also the percentage of VRMs that are securitised (reflecting the ease with which such mortgages may be sold in the secondary market).

Related to these arguments on the demand side is the suggestion that the availability of VRMs lowers the cyclical swings in the demand for mortgage credit as it becomes less important for borrowers to lock in to a *currently* desirable rate. This proposition is investigated by Goodman (1992a) among others, who presents a simple model of the demand for mortgage credit which is estimated using US data over the 1980s<sup>32</sup>. The effect on total mortgage demand of the withdrawal of VRMs is simulated, whereby it is discovered that the availability of VRMs reduces cyclical swings in the demand for mortgage credit but has a small downward effect on the level of demand<sup>33</sup>. This is consistent with the discussion above in which it is shown that the tilt effect can be made significantly worse when the borrower uses the VRM as the funding instrument.

In summary, therefore, we have seen that the use of the VRM is likely to be to the detriment of the borrower, since it may potentially worsen the effect of the tilt problem, and is highly beneficial to the lender to the extent that it reduces the problems associated with maturity mismatching. As such, the VRM has been important in alleviating some of the supply swings in the housing market which have in the past stemmed from funding constraints as a result of the inability of the financial intermediary to pay competitive deposit rates.

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<sup>32</sup> It is proven theoretically that the effect of the availability of VRMs on the interest rate elasticity of mortgage demand will be dependent upon the covariance between the interest rates on fixed rate mortgage credit and VRMs.

<sup>33</sup> This was also shown to be the case by Jones *et al* (1995) who found that the market share of VRMs was negatively related to average house prices; the interpretation was that with a higher level of principal at risk the borrower would prefer to lock in to a certain fixed mortgage rate.



### 3.4.2 The Dual Rate Variable Rate Mortgage

The standard VRM described above does reveal an important conflict of interest between the borrower and the mortgage lender. The lender has a preference over the use of a short term interest rate, since this enables the rate of interest earned on its long term mortgage assets to be directly related to the cost of its short term liabilities (used to fund its mortgage business). On the other hand, however, the preference of the borrower is towards a long term interest rate due to its lower volatility; short term changes in the rate of inflation will less likely feature in a long term nominal rate, reducing the probability that a borrower will default after facing an inflated nominal interest rate during the initial years of the mortgage contract.

The dual rate VRM represents an attempt to resolve this conflict by introducing two separate interest rates. In each period, the payment rate is used to compute the periodic payment made by the borrower using the standard annuity formula as described in Appendix 3.1, equation (A1.12). A long term rate is chosen as the payment rate to give the borrower a more stable intertemporal payment stream than if a short term rate were used. This total payment made by the borrower is then decomposed into an interest payment and the repayment of principal : the financial institution requires the borrower to repay interest on the loan at the short term debiting rate (for hedging purposes, as mentioned above) and thus the interest component of the total borrower's payment is calculated simply as the debiting rate multiplied by the amount of mortgage debt outstanding; the remainder of the borrower's total payment then goes to repayment of the principal. A new total periodic payment is then calculated for the following period based on the revised value of the outstanding debt and the process continues until the debt is repaid. Thus, the borrower will repay the mortgage loan at the long term payment rate, whilst the financial intermediary will charge interest on the loan at the short term debiting rate.

A particular disadvantage with the dual rate VRM is that as with the traditional VRM, the lender's situation has been improved but the inadequacies of the standard rate mortgage from the perspective of the borrower essentially remain (the tilt problem is

not eliminated). As Lessard and Modigliani (1975) note, "the capricious changes in initial level of payments due to inflation-swollen interest rates" remains a characteristic of the dual rate VRM, depressing the demand for mortgage funds. However, it must not be ignored that under the dual rate VRM, the specification of a long term payment rate will go some way to insulating the borrower against any sharp and unexpected changes in the periodic payment as a consequence of changes in inflation.

Finally, when the debiting rate differs from the payment rate, the periodic payment made by the borrower may either be larger than required (if the payment rate is larger than the debiting rate) or insufficient to amortise the loan (if the payment rate is lower than the debiting rate). Another way to put this is to say that if the payment rate is greater (less) than the debiting rate then the borrower will repay the loan more quickly (slowly) than the payment rate would suggest. This will hold throughout the duration of the mortgage loan but is most obvious in the final period when the final payment may or may not be sufficient to pay off the remaining outstanding debt (see example in Table A3.2.3 of Appendix 3.2). As such, the borrower may be required to make a final repayment of a different amount than that calculated<sup>34</sup>. Nevertheless, such divergences between the required and actual periodic payments should be small if the short term debiting rate and long term payment rate differ from each other only by a small amount.

### 3.4.3 The Graduated Payment Mortgage

The graduated payment mortgage (GPM), or 'low start mortgage', is one of a number of mortgage instruments that have been designed to deal with the specific problem of front-loading, the central inadequacy of the standard level payment mortgage investigated in Section 3.3.1 and also the two alternative designs suggested above. The GPM is characterised by comparatively lower *nominal* periodic payments during the initial years of the loan (in order to restrain the relatively high real payments usually induced by inflation when a standard level payment or variable rate mortgage

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<sup>34</sup> In Table A3.2.3 of Appendix 3.2, the borrower's final scheduled annuitised payment is £298.71 greater than required.



contract is used) which increase throughout the duration of the loan reaching their maximum in the final years of loan (when the real annuitised payments of more standard mortgage instruments would otherwise be low).

The rate at which the annual nominal repayment grows, known as the rate of graduation, is agreed at the beginning of the contract period and (usually) remains constant throughout the duration of the loan<sup>35</sup>. Clearly, the higher is the agreed rate of graduation, the lower will be the initial nominal repayments and the higher the nominal repayments made during the terminal years of the loan. If the borrower's preference is to remove entirely the front loading of real mortgage repayments, then a constant stream of real *expected* mortgage repayments may be generated by setting the rate of graduation equal to the expected rate of increase of the general level of prices. This would also imply a constant expected debt service ratio over the period of the mortgage loan if the rate of growth of borrower income was the same as the rate of inflation.

In theory, therefore, the GPM can be used to completely insulate the borrower from the tilting of both the real annual repayment and the payment to income ratio, and in this respect the risk of default may be lower than that of the standard level payment mortgage. The pattern of repayments under a GPM is shown in the example given in Table A3.2.4 of Appendix 3.2 where both the rate of inflation and graduation are assumed to remain steady at 4 per cent per year. However, in practice the rate of inflation is particularly difficult to predict even over an intermediate term, let alone over the duration of a long term mortgage contract. For the stream of real repayments to remain constant over the duration of the loan, the rate of inflation must remain the same as the rate of graduation for the whole term to maturity, an assumption which is clearly not credible. Nevertheless, if the graduation rate is chosen such that it is equal to the *average* rate of inflation over the duration of the mortgage loan, then the stream of real repayments over the contract period will be untrended despite exhibiting variation as inflation in the short term deviates from its long run rate.

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<sup>35</sup> In the US, a variant of this type instrument specifies an initial period over which repayments are graduated (usually between 5 and 10 years), thereafter remaining constant (at a higher level than the standard level payment mortgage) until the date of maturity.



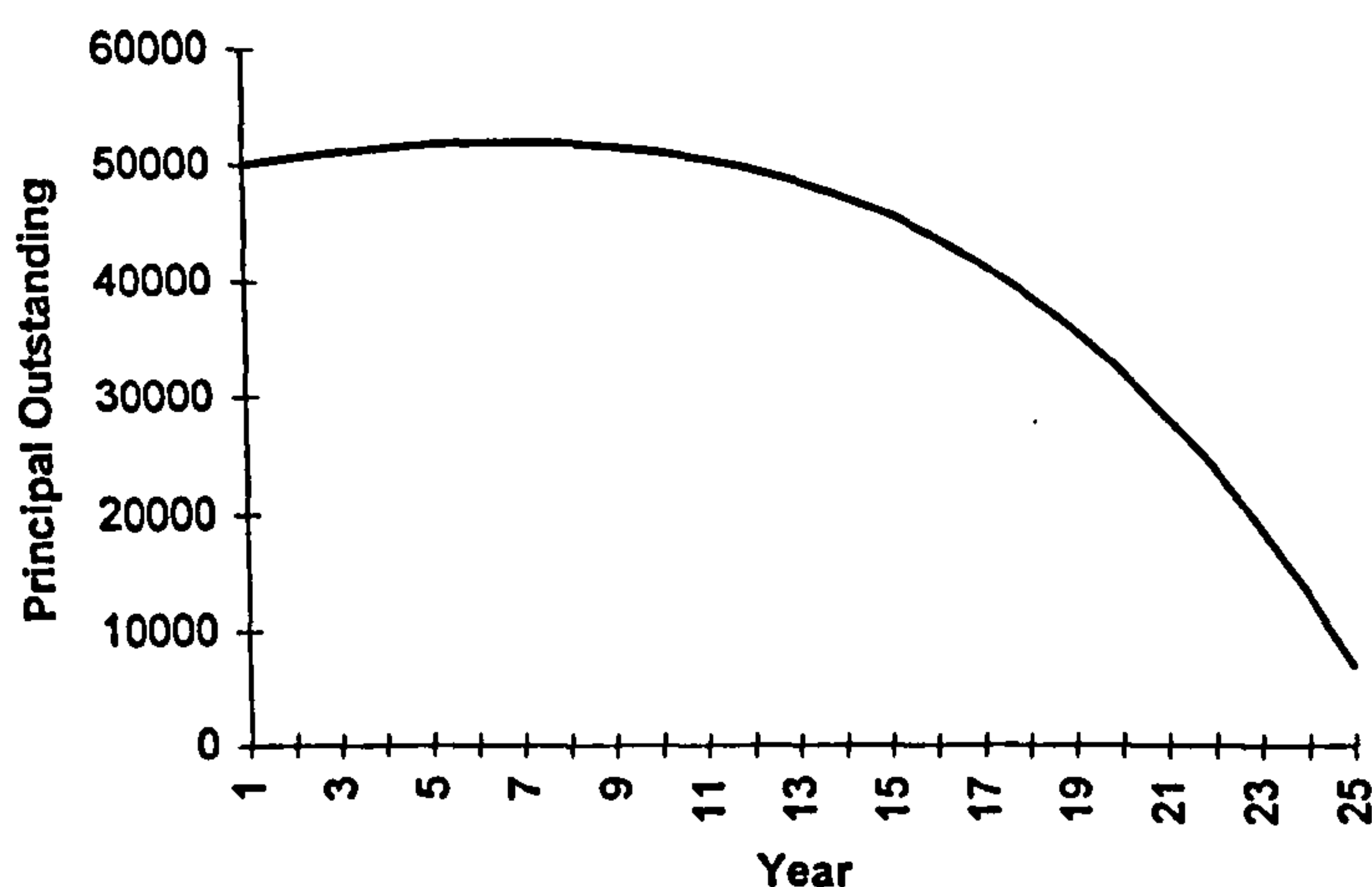
Thus, despite the fact that the design of the GPM is favourable from the borrowers viewpoint (since it has the *potential* to eliminate the cash flow problems associated with inflated real payments at the beginning of the loan), if the realisation of actual inflation turns out to be lower (higher) than expected, the borrower will face a stream of real repayments rising faster (slower) than was desired when the graduation rate was set. The principal risk to the borrower, therefore, is that inflation will turn out to be lower than expected, increasing the growth rate of real repayments and implying a higher payment to income ratio (since incomes usually rise in line with *actual* inflation) than would otherwise have been the case if the realisation of inflation was as expected. As Lessard and Modigliani (1975) suggest, the GPM is best suited to, "young families with expectations of wage growth substantially in excess of the rate of inflation". The cost in terms of risk to the borrower of using the GPM to reduce or eliminate the effect of the tilt also comes in another guise. Since the GPM comprises nominally fixed rising periodic payments, the real burden is even more sensitive to changes in the nominal rate of interest than is the standard level payment mortgage since the measure of duration is longer.

An additional problem associated with the GPM arises from the fact that the steadily increasing stream of nominal periodic payments will have implications for borrower default risk. In providing for the borrower to make lower initial nominal repayments to the mortgage lender, the use of the GPM will not only imply that the mortgagor will face a slower build up of his equity in the property (i.e. a larger balance would remain outstanding at each payment date than with the traditional mortgage instrument, possibly causing a moral hazard problem if the risk of foreclosure were to increase) but also a heavier payment burden during the terminal years of the loan than would be the case with either the standard level payment mortgage or the VRM. In fact, during the early years of the GPM contract, the outstanding mortgage debt would be expected to actually *increase* and would continue to do so for a number of years until the steadily increasing periodic payments exceed the interest charges, at which point the amortisation of the debt may begin. Despite the fact that the principal and all interest due would be fully repaid by the maturity date, the mere fact that the principal grows during the initial years has proved an important source of scepticism on the part of



both the borrower and lender (see Figure 3.6 below). Indeed, these fears are not misplaced since a borrower defaulting during the period in which the level of outstanding mortgage debt is rising would face a more severe financial penalty as they would owe a greater amount of principal to the mortgage lender.

Figure 3.6 : The Path of Outstanding Principal Under the GPM (£)<sup>36</sup>



In addition, the greater payment burden during this terminal stage of the loan is often associated with the part of the life cycle at which income growth has become more restrained, and therefore may result in raising the risk of default. Nevertheless, in general it may be argued that the relative risk of default is greater during the initial period of any loan contract, when despite the fact that borrower income is generally at the peak of its expansion, the borrower may be suffering from money illusion and thus may not appreciate the burden of the real repayment schedule he faces. If this were the case, then the GPM must surely be advocated on grounds of the lower risk of default.

Finally, we must note that the use of the GPM does not resolve the mismatched portfolio situation of the lender since the nominal mortgage interest rate and the rate of graduation are fixed from the outset of the contract. As such, the GPM instrument

<sup>36</sup> The simulation data upon which this figure is based are presented in Table A3.2.4 of Appendix 3.2. The calculations of the nominal growing repayment stream are based on equation (A1.9) derived in Appendix 3.1.

significantly improves the borrower's position with respect to the front loading of real repayments (albeit at a potential cost of risk) whilst commensurately worsening that of the lending institution. In summary, the risk to the borrower (lender) is that wage (price) growth will fall short of (exceed) the rate of graduation (see Section 3.4.4 for a discussion of the price level adjusted mortgage, the design of which can overcome this problem). Thus, there is essentially a trade-off between borrower risk and the front-loading of real payments for households deciding to use the GPM as the vehicle with which to borrow long term funds. We must therefore be aware of these added costs to the borrower and lender when assessing the attractiveness of the GPM instrument in addressing the problem of the tilt.

### 3.4.4 The Price Level Adjusted Mortgage

Despite their attempts to correct the distortionary problems within the market for mortgage finance, neither the VRM nor the GPM provide completely satisfactory solutions to the difficulties resulting from the existence of high and uncertain rates of inflation and nominal interest. As we saw, the VRM corrects for the maturity mismatching problems of the lender but at the expense of exposing the borrower to greater potential risk arising from changes in the rate of inflation (and thus to changes in the nominal rate of interest). The GPM, on the other hand, worsens (with respect to the VRM) the lender's maturity mismatched situation whilst simultaneously exposing the borrower to the risk that inflation may not turn out to be the same as expectations. The Price Level Adjusted Mortgage (PLAM) endeavours to overcome these problems and to offer a complete solution in which both the borrower and lender are better off than under either the standard level payment mortgage or GPM outlined above.

The design of the PLAM enables us to recreate a constant real stream of periodic payments *irrespective* of the rate of inflation or indeed whether inflation is expected or unexpected. This is achieved by setting the debiting rate equal to the real rate of interest and revaluing the outstanding debt each period by the rate of inflation (i.e. the inflation rate multiplied by the outstanding value of the mortgagor's debt). Both the principal and the annual payment in the subsequent year will then be increased by the



rate of inflation ensuring the real periodic payment remains constant over the duration of the mortgage contract<sup>37</sup>.

The operation of the PLAM is illustrated in Table A3.2.5 of Appendix 3.2 . The payment rate (the real rate of interest) is assumed to be 3 per cent, which implies that the first periodic payment will be £2,986.25<sup>38</sup>. The interest charge and revaluation of principal are both added to the initial debt, and the annuitised payment is deducted having the effect in the initial years of the contract of raising the level of debt owed by the mortgage borrower. By recalculating the annual payment each period, the total cost to the borrower is actually the nominal rate of 6 per cent interest (3 per cent interest charges plus 3 per cent inflation of debt), although the low payment rate enables the nominal payments made during the initial stages of the loan to remain low.

Not only will the annuitised real payment remain constant over the duration of the mortgage but so too will the nominal payment to income ratio if the borrower's income rises in line with inflation<sup>39</sup>. Again, however, the borrower will be subject to the risk that his income rises at a slower rate than the price level. In addition, although it is true that under inflationary conditions the PLAM carries a greater degree of default risk due to the rising stream of nominal periodic payments over the life of the loan, Cohn and Fischer (1975) argue that it may have the effect of attracting further lenders into the market for housing finance as a result of the inflation 'hedging facility' it offers.

Despite the many advantages of the PLAM in theory, practical success has been limited. It has been suggested that potential mortgagors suffering from money illusion have been deceived into thinking that the maintenance of a constant real periodic payment has increased the risk of higher payments relative to the standard level

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<sup>37</sup> The PLAM is derived from the family of alternative mortgage designs called shared appreciation mortgages, whereby the lender essentially 'shares' in the appreciation of the value of the house in return for either a lower or more stable mortgage repayment stream.

<sup>38</sup> Because each repayment is made at the end of period, the periodic payments will be based on the level of outstanding debt revalued at the current period's inflation rate. For example, the first periodic payment will not be calculated based on the initial debt of £50,000 but rather for the revalued debt of  $£50,000 \times 1.04 = £52,000$ .

<sup>39</sup> In the example given in Appendix 3.2, the borrower's income rises at a real rate of 2 per cent and thus the payment to income ratio actually declines over the life of the mortgage loan.



payment mortgage (in other words, borrowers have perceived the risk of unexpected inflation to be on the upside only). This is untrue given the assumption that the expectation of inflation incorporated in the nominal contract rate of the level payment mortgage is unbiased given the set of available information at the contract date and also that the borrower's income rises at least at the rate of inflation. In such conditions, a fixed *real* payment over the life of the loan should actually reduce the risk to the borrower. However, as previously mentioned, to the extent that the income of the borrower may rise at a lower rate than the rate of inflation, the borrower will be exposed to inflation risk and the aversion to entering the contract is justified.

Thus despite being a promising alternative to the standard mortgage in a world of uncertain inflation, the PLAM has proved exceedingly difficult to adopt in practice; the equal treatment of tax relief on both the interest payment and the revaluation is an example of such a complication. Nevertheless, recently a number of 'hybrid' PLAMs have been suggested which combine the desirable elements from both the fixed rate mortgage and the standard PLAM discussed in this section. For example, Scott *et al* (1993) recommend a mortgage design whereby the parties to the contract decide firstly upon the degree to which they desire inflation risk to be partitioned between the borrower and lender, and secondly the rate of graduation of the borrower's nominal repayment stream, both of which are assigned a value between 0 and 1<sup>40</sup>. The *traditional* PLAM assigns all of the risk of inflation to the borrower (in contrast to the level payment mortgage where the lender bears all of the risk) and tends to have the steepest repayment graduation schedule; the borrower may therefore wish to transfer some of this risk back to the lender. The hybrid PLAM allows him to do this without requiring the borrower to sacrifice some of the more desirable features of the PLAM (such as a graduated nominal payment stream<sup>41</sup>).

Scott *et al* derive equations for the annuitised repayments and the outstanding balance on the hybrid PLAM which are then both simulated. Essentially, since the standard

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<sup>40</sup> These parameters, which may be chosen independently, will clearly depend on the household's stage in the life cycle.

<sup>41</sup> Indeed the borrower may want to tilt the nominal repayment stream to match the expected rise in the level of his income.



level payment mortgage and the traditional PLAM represent the extreme cases of non-indexing and indexing respectively, all of the simulated repayment and outstanding debt paths for the hybrid instrument are bordered by these two boundary cases. However, an important criticism of their model is that they concentrate excessively on the effect of the hybrid PLAM on the path of the *nominal* stream of mortgage repayments, failing to recognise explicitly that the tilting of the *real* repayment stream may be a more significant factor in the determination of mortgage demand.

A final mortgage design considered in this section is a hybrid of the traditional PLAM and the variable maturity mortgage and has been discussed extensively by Simonovits (1992) and Buckley *et al* (1993). In the paper by Buckley *et al*, it is noted that the indexation of mortgage payments to the general price level will subject the borrower to the risk that his income will rise at a lower rate than inflation (thus increasing the risk of borrower default), whereas the use of a wage index will present the lender with the risk that the percentage change in the price level will be greater than wage inflation<sup>42</sup>. To address both of these concerns, the dual indexed mortgage (DIM) is suggested, whereby the borrower's annuitised repayment is indexed to wage inflation and the outstanding loan balance is adjusted each period by the rate of general price inflation. The maturity of the instrument is then lengthened (shortened) to account for shortfalls (excesses) in the annual repayment as a result of wage inflation being lower (higher) than the rate of general price inflation.

Although this hybrid instrument has the advantage of reducing the heavy repayment burden to the borrower during the initial years of the loan (and thus lessening the front loading problem) whilst preserving the present value of the lender's real receipts (and avoiding the mismatched maturity situation), there exist four important problems with the design. Firstly, the initial term to maturity must be set such that any subsequent variations in the amortisation period may be accommodated without difficulty. Indeed, both the lender and borrower will bear the risk that the spread between price and wage inflation becomes too large for the loan maturity to be rescheduled (thus requiring higher repayments). Secondly, if this were the case, then the real

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<sup>42</sup> In both cases, therefore, the risk is that borrower income will not remain constant in real terms.

repayments received by the lender may not match their real liabilities, causing a *real* interest rate risk. Thirdly, when the future relationship between inflation and wage growth is uncertain, the borrower may be unable to make a decision on whether he will or will not be able to afford the mortgage over the duration of its term, the real repayment schedule and nominal payment to income ratio being dependent upon the vagaries of inflation. Finally, it has been argued that the use of a mortgage indexed to wage inflation would actually serve to fuel wage growth.

Simonovits (1992) has also investigated the idea of a dual rate indexed mortgage, suggesting that either the annual payment could be recalculated during each period whilst holding the maturity constant (the 'iterative' DIM), or alternatively upper and lower bounds could be specified for the expected periodic repayments (the 'combined' DIM)<sup>43</sup>. Both are proposed as solutions to the problem inherent in the traditional DIM that expectations persistently differing from actual price and wage growth may lead to a significant lengthening or shortening of loan maturity<sup>44</sup>.

### 3.4.5 The Constant Payment Rate Variable Rate Mortgage

The constant payment rate VRM (CPVRM), like the PLAM described above is designed with the intent of smoothing the stream of real periodic payments throughout the life of the mortgage loan contract<sup>45</sup>. In order to achieve this objective, the structure of the instrument is similar to that of the dual rate VRM except that the payment rate in this case is fixed at the real rate of interest expected to prevail over the duration of the mortgage contract (the debiting rate remains floating, a short term rate being chosen to reflect the cost and maturity of funds). As Lessard and Modigliani (1975) note, the more stable are real interest rates, the more similar will be the payment stream to that of the PLAM.

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<sup>43</sup> A drawback of the combined DIM is that it will lessen the flexibility of the lender in responding to changes in money and capital market conditions.

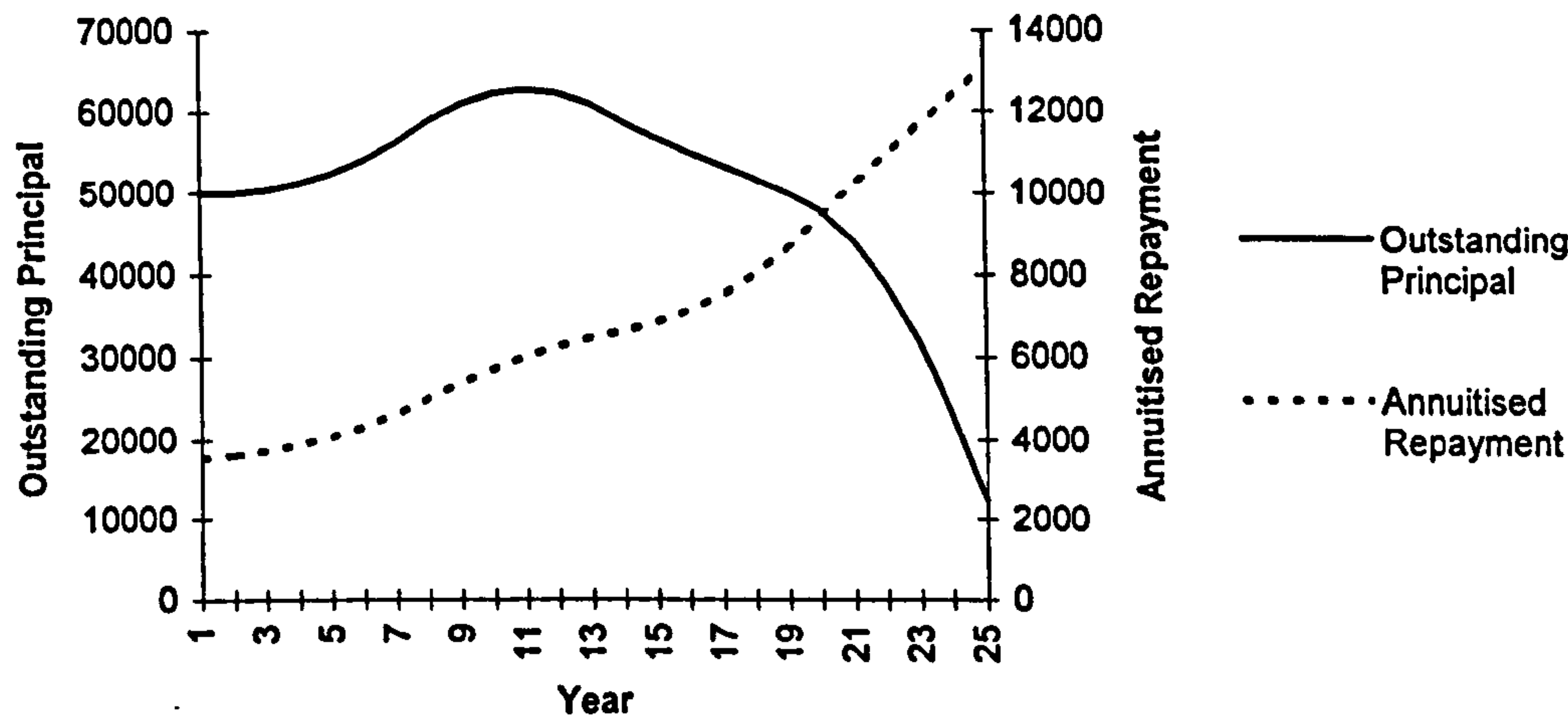
<sup>44</sup> The paper works through the financial mathematics of the proposed changes to the DIM and presents the implications for the stream of repayments generated by divergent forecasts of wage and price growth.

<sup>45</sup> The CPVRM was suggested by Lessard and Modigliani (1975) among others at a conference organised by the Federal Reserve Bank of Boston.



The pattern of repayments made over the life of the CPVRM will still depend on the rate of inflation despite the fact that the payment rate remains constant for the entire duration. This may be seen in Table A3.2.6 of Appendix 3.2; the intertemporal paths of the annual repayment and outstanding principal are illustrated in Figure 3.7 below.

**Figure 3.7 : Amortisation of Debt Under a CPVRM when Inflation is Variable (£)**



In this case, the outstanding balance of mortgage debt is non-linear with the level of outstanding debt rising until the eleventh year to over 125 per cent of the original debt. As mentioned previously with regard to the GPM and PLAM designs, this may act as a severe disincentive to the mortgage borrower; a default at the stage of the mortgage loan where the level of outstanding debt is at its peak clearly constitutes a greater financial burden to the borrower than would be the case in the later years of the contract when the borrower's equity is higher. Despite the constancy of the payment rate, the annuitised payment will rise in the subsequent period whenever the current period debiting rate exceeds the payment rate, since this will cause a rise in the outstanding balance of mortgage debt owed by the borrower.

The structure of the CPVRM allows the debiting rate to be flexible with respect to both its term and level, which for purposes of prudence (i.e. maturity matching) could be set at the minimum length of time for which the funding rate may be held fixed.

The structure of this type of instrument can therefore be adjusted to reduce the extent of the intermediary's supply problem caused by unexpected inflation.

### 3.5 SUMMARY AND CONCLUSIONS

The move towards more complex instrument designs in the market for mortgage finance over the last 25 years has been driven by the inappropriateness of the standard level payment mortgage especially during periods in which inflation is high. The main problem has been that the standard level payment mortgage ignores the changes in inflation and nominal interest rates, borrower income and the market value of the property during the period over which the loan is held. Among all of the alternative mortgage designs, from the borrower's viewpoint (and thus from the perspective of this thesis) only the PLAM acts to *perfectly* insulate the borrower against the front loading problem (even in the presence of unexpected inflation). The adoption of the PLAM instrument would therefore be expected to encourage additional mortgage demand which would have otherwise been latent in the presence of the severe liquidity problems created from the use of more standard mortgage instruments<sup>46</sup>.

Alm and Follain (1984) consider the effectiveness of a number of mortgage designs in increasing housing demand by modelling the household as maximising life cycle utility in a world of perfect certainty by choosing consumption, house size and the initial loan to value ratio subject to a number of constraints<sup>47</sup> over a typical holding period. Simulations were undertaken for different levels of inflation and initial wealth and for four different mortgage instruments. It was found that when the standard level payment mortgage was used, moderate rates of inflation increased the demand for housing<sup>48</sup> whereas the effects of the liquidity constraints at higher rates of inflation were more than offsetting, causing demand to fall below that of the zero inflation

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<sup>46</sup> There exist considerably more mortgage designs than the main instruments outlined in this chapter. An example of the flexibility in formulating new mortgage designs is shown in a paper by Goodman and Wassmer (1992) who undertake a multi-period maximisation to determine an optimal theoretical payment schedule which takes into consideration the needs of both the borrower and lender.

<sup>47</sup> These include payment to income and loan to value constraints, a budget constraint and a non-negative wealth constraint.

<sup>48</sup> As we saw in Section 3.3.2, the reasons for this were primarily the lower real return on competing financial assets and the reduction in the after-tax user cost of housing.



case; this conclusion echoes that of the earlier study by Alm and Follain (1982). The PLAM was confirmed to be the most effective instrument with which to combat the liquidity effects on housing (and thus mortgage) demand resulting from inflation; it was found that borrowers should be willing to pay up to 3.5 per cent<sup>49</sup> over the rate charged on the standard level payment mortgage for the use of the PLAM instrument.

However, we must be aware that because alternative mortgage instruments can do nothing to raise the wealth of the borrower, their effectiveness at addressing the reduction in demand as a result of the front loading problem is considerably diminished when the downpayment constraint on the borrower is binding. In addition, concern has been expressed given the slower build-up of homeowner equity when one uses an alternative mortgage instrument (see Figures 3.6 and 3.7 in the previous section for illustrations).

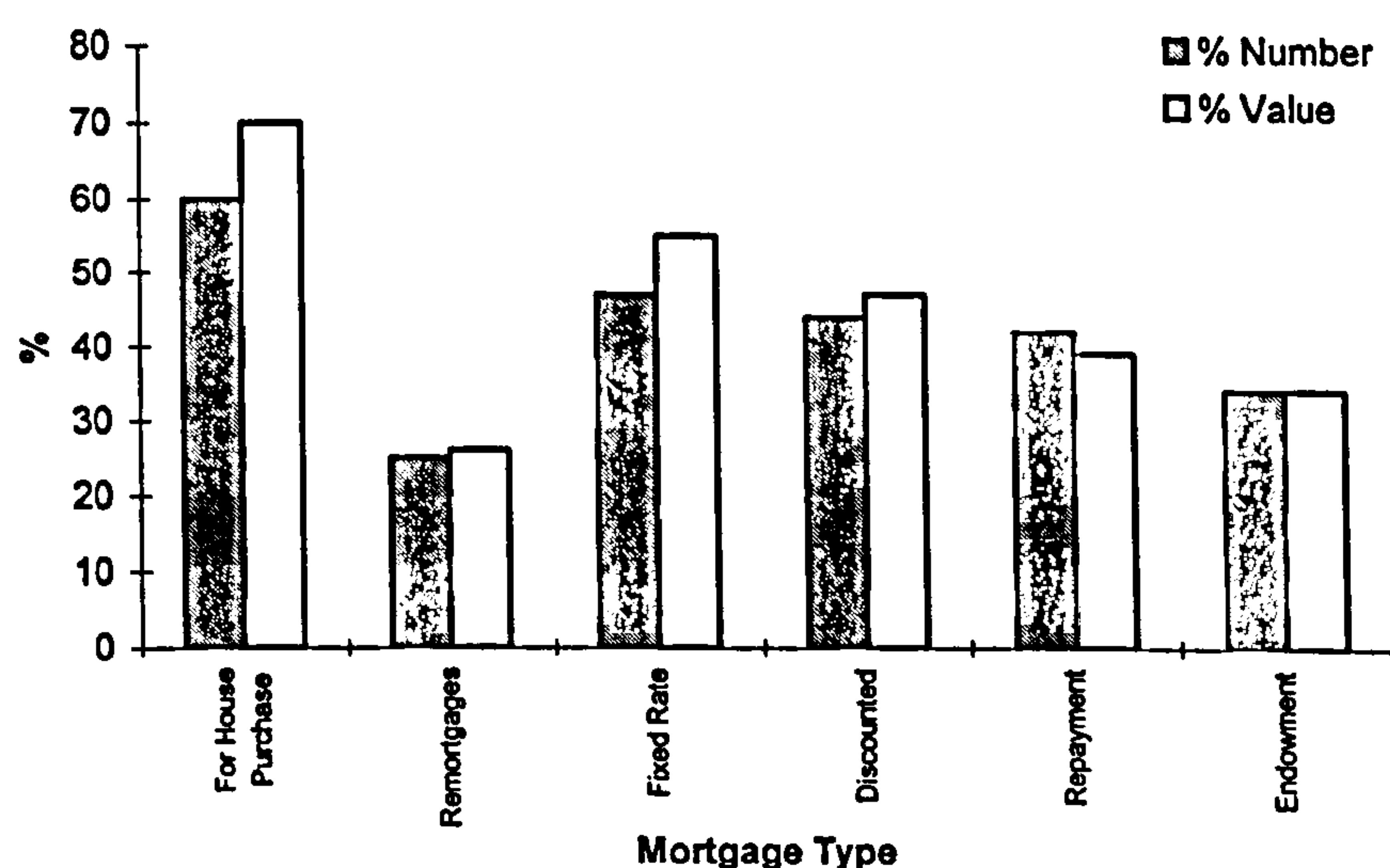
The supply problem, whereby mortgage lending institutions have found themselves in a maturity mismatched position and thus exposed to interest rate risk has, since the mid-1980s, become less important with financial institutions being able to hedge their positions through the securitisation of their mortgage books. Essentially, the trend has been for lenders to swap tranches of their mortgage loans for assets yielding a variable rate of return thereby eliminating the risk that nominal interest rates may move against them. The introduction of more complex mortgage designs has not hindered the ability to engage in securitisation as much as could have been expected since investment banks offering such services have become equally more sophisticated. This was recognised even as early as the 1970s; as Marcis (1980) notes, "research indicates that, practically speaking, there are no real barriers to trading AMIs [alternative mortgage instruments] in the secondary market and there is no reason to doubt that a viable secondary market can exist [for alternative mortgage instruments]". The price at which these securitised instruments will be traded will then depend upon the volatility and uncertainty of interest rates, the shape of the yield curve, the risk that the borrower may default on the mortgage and the possibility that the maturity date of the loan will vary. One may have expected this move towards securitisation to allow

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<sup>49</sup> According to a compensating variation calculation.

mortgage lenders to concentrate solely on their borrower's needs; however, the continued use of VRMs as the vehicle of mortgage finance, the re-emergence of fixed rate debt during the initial term of the mortgage contract and the lack of enthusiasm for the alternative mortgage designs discussed in the previous section confirms that the phenomenon of the front loading of real annuitised payments is an ever present problem for borrowers in the current market for mortgage finance<sup>50</sup>.

**Figure 3.8 : Number and Value of Gross Advances as a Percentage of All Mortgage Loans (1998 Q3)<sup>51</sup>**



Source : Council of Mortgage Lenders

There is certainly scope for further work on the effect of the front loading of real mortgage repayments on the demand for mortgage finance, since for the majority of studies undertaken on the demand for mortgage finance (both empirical and theoretical) the tilt effect has largely been ignored<sup>52</sup>. Specifically, the literature would benefit from a comparative study of various household types and the responsiveness of their demand for mortgage finance following changes in the rate of inflation and the nominal mortgage interest rate. Clearly, any such research must control for variations in demography between each household cohort and also the average value of housing

<sup>50</sup> Nevertheless, it has been suggested that the use of more standard mortgage instruments has aided the process of securitisation as such mortgages are more simple to value and sell in the secondary market.

<sup>51</sup> The figures in the bar chart are not mutually exclusive.

<sup>52</sup> Exceptions include Meen (1990a).



which is desired by each group (among other factors). The result of such a study would aid in the identification of the group of potential mortgagors who would benefit the most from alternative mortgage designs as opposed to either the standard level payment mortgage or VRM. This would then allow mortgage lenders to be better placed in targeting borrowers when selling their variety of mortgage products.

## CHAPTER 4

### Modelling House Prices, Arrears and Possessions

#### 4.1 INTRODUCTION

The determination of UK house prices has recently attracted considerable attention from economists, reflecting concern over their observed instability over the past few years<sup>1</sup>. It has been alleged (see Allen and Milne (1994)) that a combination of high interest rates, declining output and employment, and falling inflation caused the serious problems that existed within the UK housing market in the early 1990s<sup>2</sup>.

It is generally agreed in the housing finance literature that the origins of such problems may be traced back to the financial deregulation and liberalisation of the late 1970s and early 1980s which was to be profound in altering the structure of the UK housing and mortgage markets. The abolition of exchange controls in 1979, the abandonment of the building society cartel in 1983 and the introduction of bank and building society legislation in the latter half of the 1980s all contributed to a greater degree of competition between building societies and other financial institutions in both their mortgage and deposit markets (see Chapter 2 for a full analysis of these and other changes in the market). This led to a marked reduction in the extent of mortgage rationing, which underpinned the boom in mortgage lending, house prices and housing market activity in the second half of the of the 1980s. The reduction in rationing over the period can be appreciated by considering the movement of the loan to value ratio which is shown below in Figure 4.1. This ratio, which remained predominantly between 75 and 80 per cent throughout the 1970s, increased sharply from the second

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<sup>1</sup> Factors that are generally cited in the literature as important in generating house price instability include financial liberalisation (regime switching from a period of rationing to the absence of rationing could be expected to affect both the demand for and price of housing), demographic change, the attitude to owner occupation and consumers expectations.

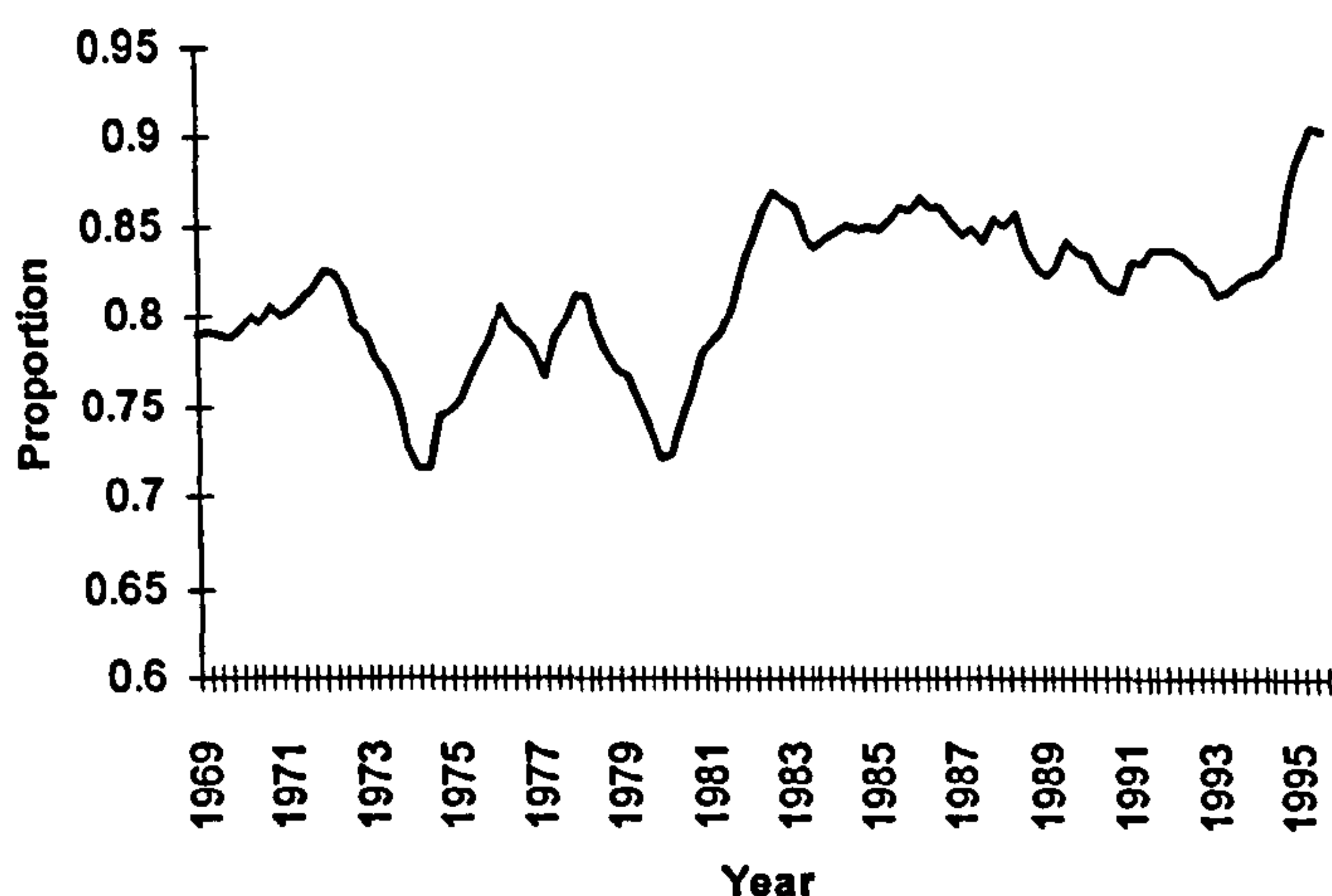
<sup>2</sup> It has been observed in a number of countries (including the UK) that there has been a tendency for house prices to rise faster than the general price level, which prior to the 1990s was attributed to the combination of high inflation and, "a tax system which confers benefits to owner occupied housing that other forms of investment do not enjoy" (Meen (1990a)).



quarter of 1980 and has maintained a level of around 85 per cent for the majority of the 1980s and 1990s<sup>3</sup>.

Brookes *et al* (1994) claim that as a result of the reduction in mortgage rationing, household sector mortgage debt has risen from less than 25 per cent of annual disposable income in 1980 to around 75 per cent in 1992. Coupled with high levels of nominal mortgage interest rates during the early 1990s, this growth led to increased concern over the number of borrowers facing repayment difficulties.

Figure 4.1 : The Loan to Value Ratio for First Time Buyers<sup>4</sup>



While it would be difficult to isolate any *single* cause of the housing market boom, the coexistence of high inflation and the tax deductibility of nominal mortgage payments may certainly be pinpointed as an important factor in the growth observed in the housing market in the late 1970s. Following the boom in house prices between 1985 and 1989, the late 1980s and early 1990s saw the end of the expansion in housing market turnover, and from 1989 to 1994, house prices fell in both real and nominal terms, representing the first sustained nominal decline since the 1950s<sup>5</sup> (most notably

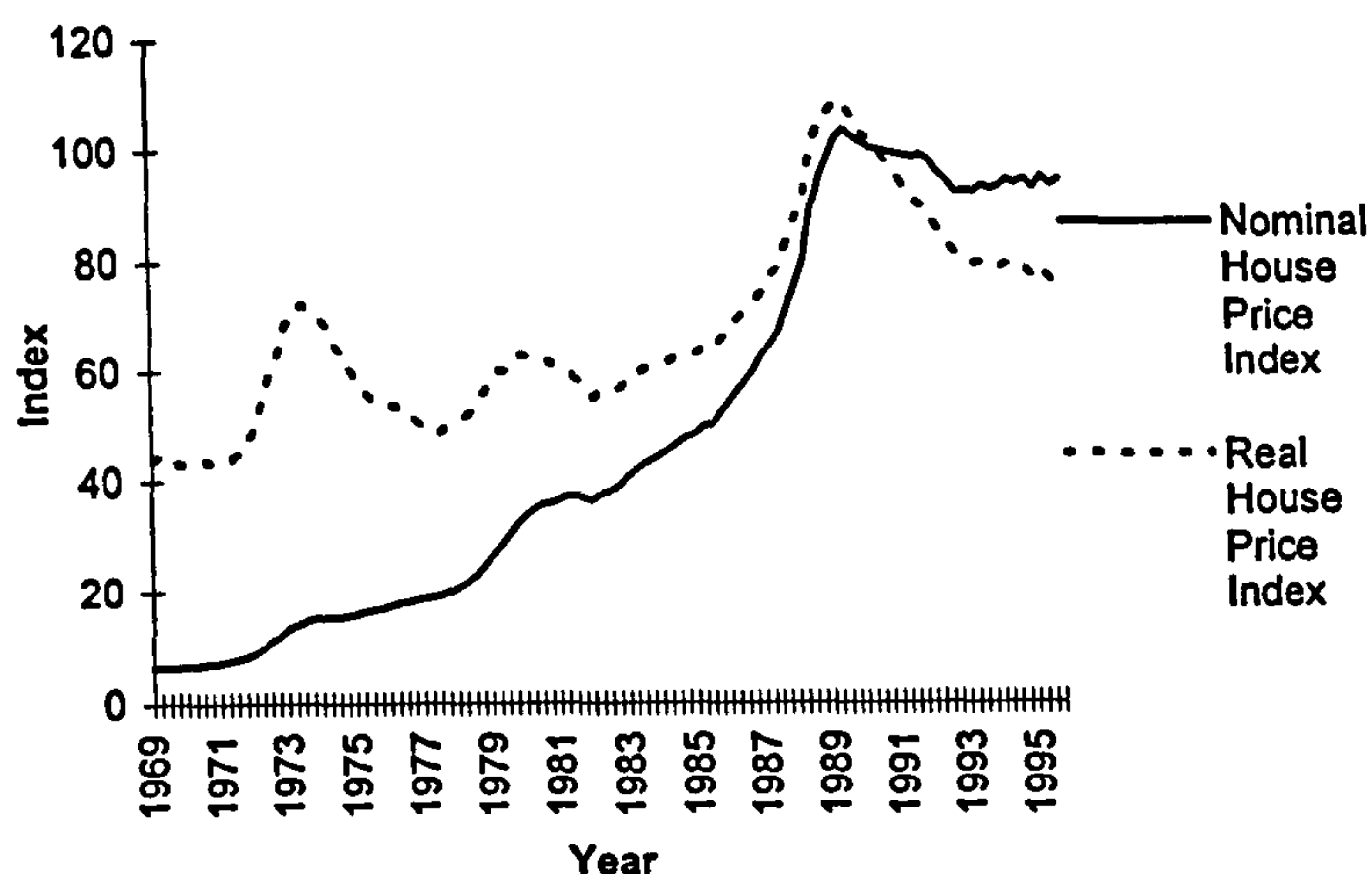
<sup>3</sup> This has been true up until only recently when we have observed significant increases in the ratio to above 90 per cent.

<sup>4</sup> All figures in this section are constructed using seasonally adjusted data.

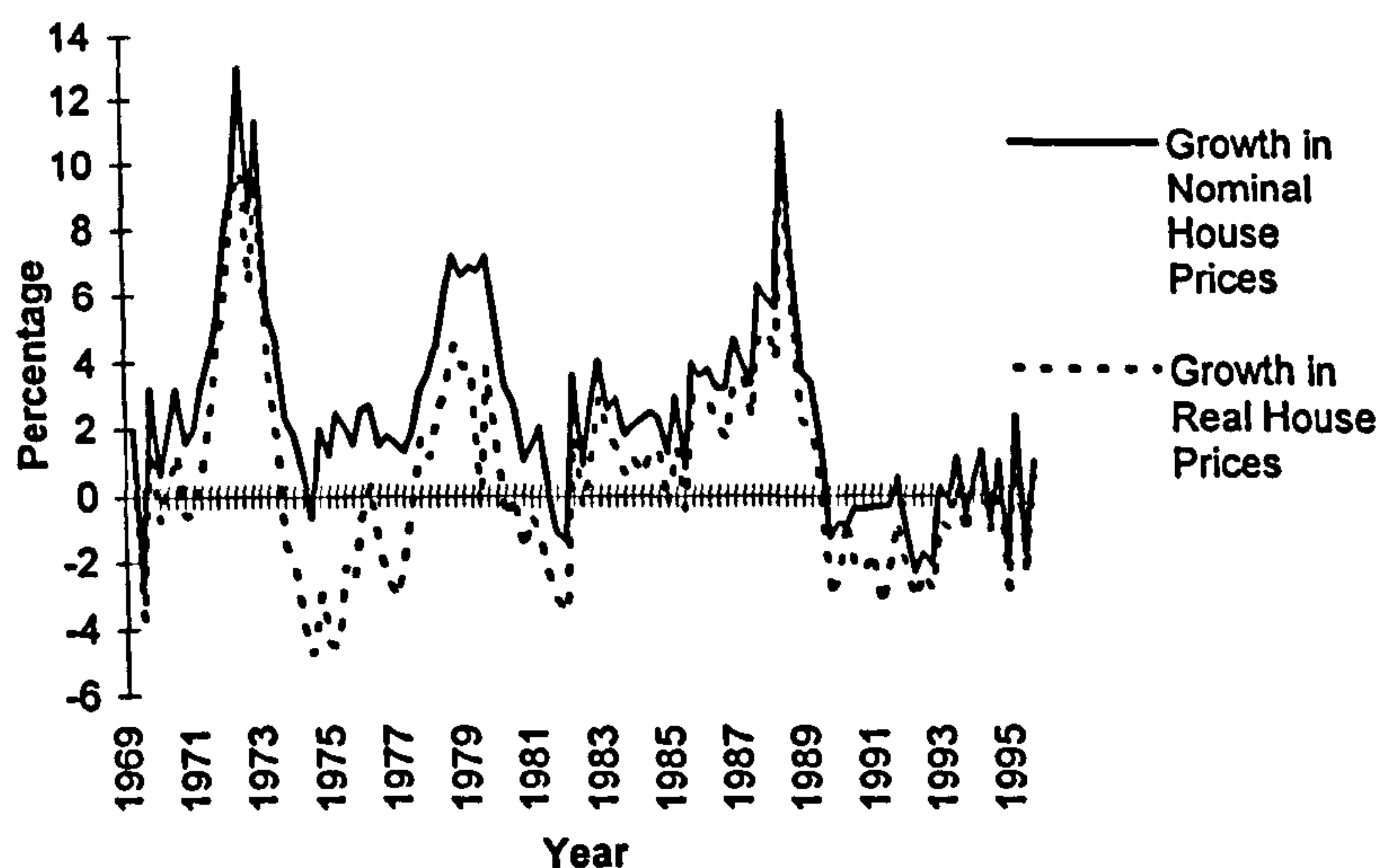
<sup>5</sup> During the three years between 1989Q4 and 1992Q4, seasonally adjusted nominal house prices increased only once (in the final quarter of 1991); in all other quarters the nominal house price index fell, with the largest percentage drop in the seasonally adjusted series of over 2.3 per cent being

in the South East of England)<sup>6</sup>. The pattern of house price fluctuations since 1969 is illustrated in Figures 4.2 and 4.3 below.

**Figure 4.2 : The Nominal and Real Mix Adjusted House Price Index<sup>7</sup>**



**Figure 4.3 : The Quarterly Growth in Nominal and Real Mix Adjusted House Prices**



recorded in the second quarter of 1992 (the unadjusted series fell by a staggering 3.57 per cent in the final quarter of 1992).

<sup>6</sup> For an empirical analysis of regional house prices and possessions see Reilly and Witt (1994) and for regional variations in mortgage arrears see Doling and Stafford (1987).

<sup>7</sup> The mix adjusted house price data is provided by the Department of the Environment, Transport and the Regions and is based on a 5 per cent sample of building society mortgages (excluding dwellings purchased without a mortgage or loan from any other source). Since the mix (type, size, location and age of dwelling) changes through time, a weighted house price series that takes account of this provides a better measure of true house price movements than an index based on a simple average price (where variations in mix are ignored).



In addition to falling house prices, construction plummeted by 30 per cent during the period and turnover stagnated. This 'boom-bust' type occurrence is, however, by no means new in the market for housing. Over the past 30 years, the cyclical nature of the market is illustrated by the fact that on three separate occasions house prices have increased at very rapid rates (from Figures 4.2 and 4.3 above these periods may be identified as 1972-1974, 1978-1980 and 1985-1989), followed by falling real house prices. The uniqueness in the last cycle is not only the duration of the preceding boom period but also the ensuing sustained fall in *nominal* house prices. Recovery of the growth rate in both the nominal and real house price series has been particularly slow following the housing market slump of the early 1990s, although more recently (from the beginning of 1999) house prices have started to grow more rapidly once again.

It is useful to examine the link between the slump, the rapid increase in the accumulation of arrears and the taking into possession of properties<sup>8</sup>. The 1980s' growth in owner occupation coupled with high levels of nominal mortgage interest rates and an acute boom in house prices towards the end of the decade led to increasing concern over the number of borrowers facing repayment difficulties, with many first time buyers (purchasing at the peak of the boom on high loan to value ratios) holding properties worth less than the mortgage secured on them (for a discussion of the trend in negative equity see Bank of England Quarterly Bulletin (1992)). Households simultaneously experiencing this so called 'negative equity' phenomenon and mortgage repayment difficulties were less likely able to sell their property to pay off the debt or renegotiate a further loan (usually based upon the amount of unwithdrawn equity in the property). Clearly such households were left more vulnerable to being possessed by mortgage lenders<sup>9</sup>.

Figures 4.4 and 4.5 below illustrate how, over the past decade, the number of borrowers whose properties have been taken into possession or who have accumulated arrears has increased significantly. However, both still represent only a small

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<sup>8</sup> This paper follows the convention of referring to a dwelling as being 'taken into possession' rather than 'repossessed' since mortgage lenders are not the previous owners of the dwellings of which they obtain possession.

<sup>9</sup> Hendershott and Villani (1977) note that, "lenders who anticipate increasing house prices may acknowledge the decreased risk of their investment by lowering downpayment ratios".

proportion of the total number of mortgage loans outstanding. During 1991 (when household possessions reached their peak) the flow into possession constituted less than 0.8 per cent of the total number of mortgages outstanding (a total of slightly over 75,000 households were taken into possession in 1991), while the proportion of borrowers experiencing arrears in excess of 6 months was, in the second half of 1992 (when arrears of over 6 months reached their peak), just over 3.5 per cent (this is, however, over three times that of the proportion recorded in the first half of 1990).

Figure 4.4 : The Quarterly Flow into Possession

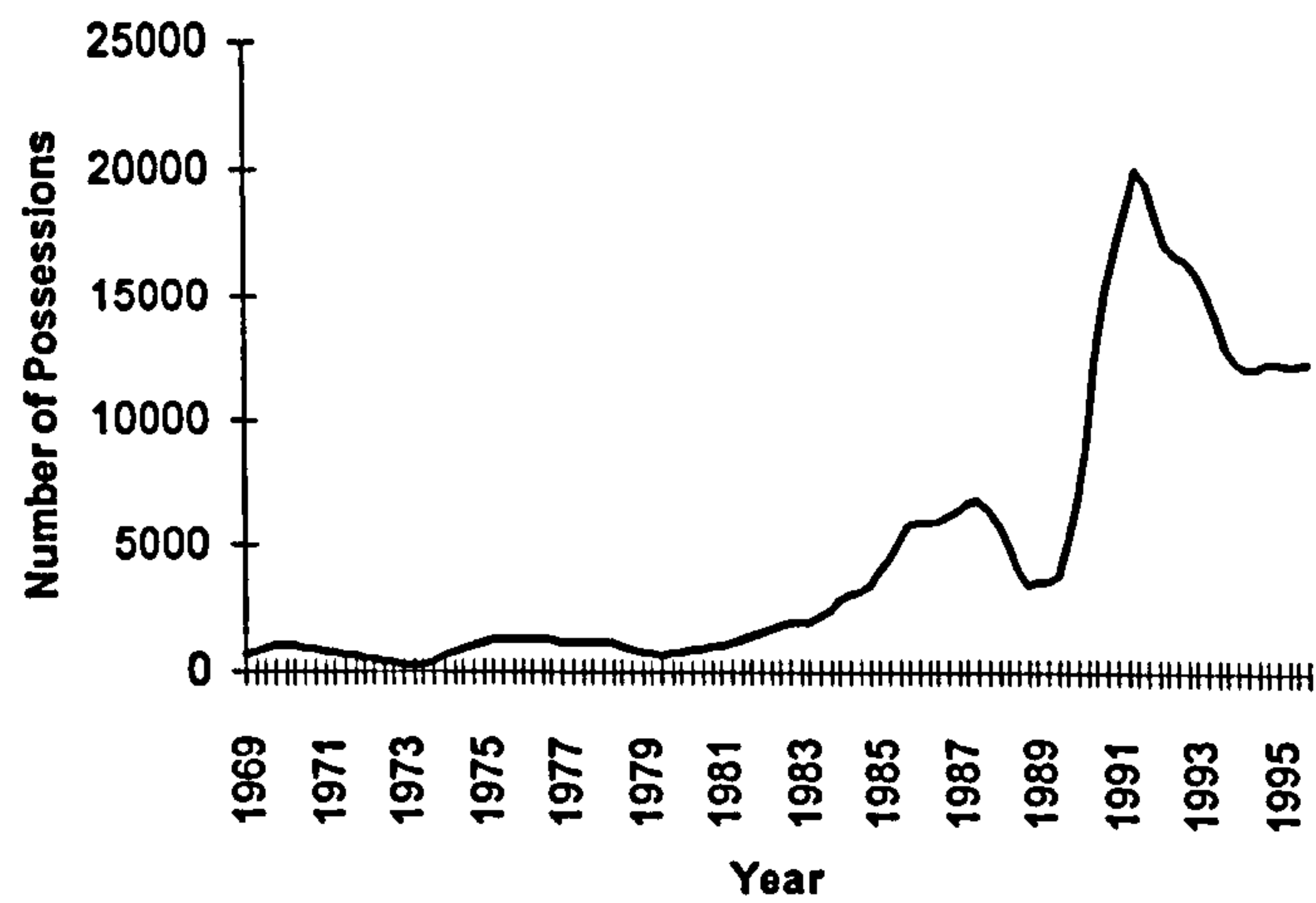
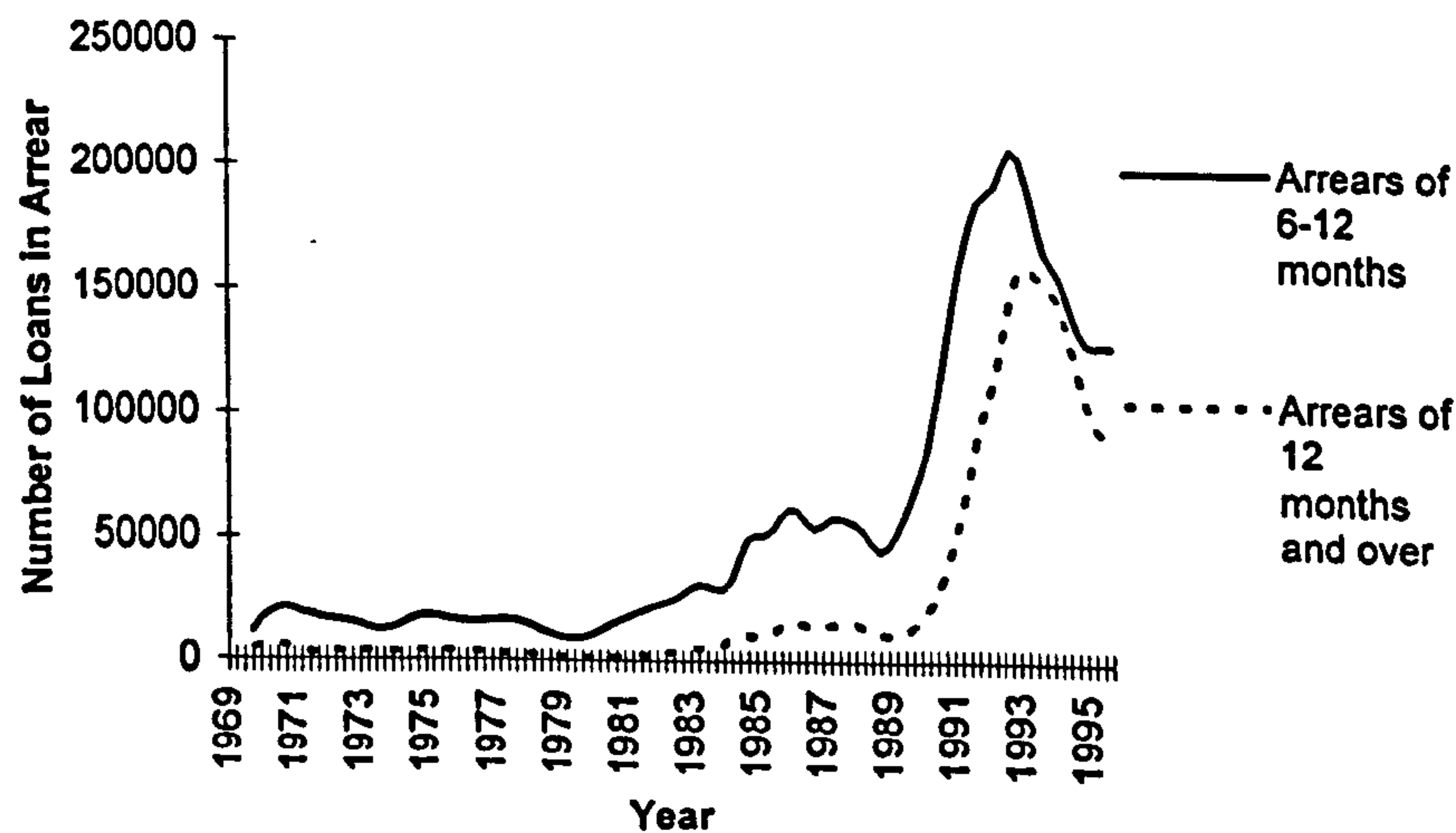


Figure 4.5 : Loans in Arrear at End of Period





Clearly noticeable from Figures 4.4 and 4.5 above are the more recent trends in mortgage arrears and possessions, which have (from 1993 and 1992 respectively) started to decline. The total number of mortgages with arrears of 6-12 months was 133,700 at the end of 1994, a reduction of nearly 19 per cent on its 1993 end-period figure of 164,620. Similarly, the number of households taken into possession by mortgage lenders during 1994 stood at 49,210 (its lowest level since 1990), a fall of almost 16 per cent from 1993.

It is argued by the Council of Mortgage Lenders (CML)<sup>10</sup> (1995) that the reduction in both the number of possessions and arrears could be attributed to, “the combination of lower interest rates, good arrears management [through lenders rescheduling payments and accepting reduced monthly amounts], the direct payment of income support and borrowers’ own perseverance [making strenuous efforts to reduce their mortgage arrears by making additional payments].”

In addition, the CML accused the government of lacking any long term commitment to reducing mortgage arrears. Criticism was directed specifically at planned changes to income support, the further reductions in MIRAS benefits and the need to buy private mortgage insurance. It was also noted that the reversal in the previous downward trend in interest rates in 1994 would have added significantly to the difficulties faced by mortgage borrowers. As a consequence, the CML forecasted a rise in both mortgage arrears and possessions in 1996. In fact during 1996, the number of mortgages in arrears and properties taken into possession fell substantially<sup>11</sup>.

Explaining the causes of mortgage repayment difficulties has assumed a greater importance in the light of the growth in owner occupation and of household mortgage liabilities over the past decade, although there exists little consensus as to their *precise* determinants. An important feature of the 1980s’ housing market boom and the subsequent slump has been the sale of council houses which resulted in a rapid

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<sup>10</sup> Formerly the Building Societies Association (BSA).

<sup>11</sup> This forecasting error may be due to the fact that the basic rate on mortgages fell by 1.5 per cent between 1995Q4 and 1996Q4, whereas the CML was anticipating a further rise.

increase in owner occupation. Ex-council house tenants enjoying a new type of tenure found themselves especially vulnerable to the inability to sustain the long term commitment of making regular mortgage repayments. It had been one of the Thatcher administration's primary goals to increase home ownership (this was successfully achieved with the percentage of owner occupiers rising from just under 55 per cent at the end of 1979 to almost 66 per cent at the end of 1990), and government policies were designed to accomplish this (for example the Housing Act of 1980 gave council house tenants the right to a local authority mortgage with which to purchase their home based on liberal financial criteria). It is widely agreed that this has been an important cause of the upturn in repayment difficulties during the early part of the 1990s.

Coles (1992) notes that the increase in arrears and possessions have been caused by the, "exceptional conditions in the mortgage market in 1987, 1988 and 1989 [which] have meant that a relatively high proportion of loans made in that period were stretching the resources of borrowers, and hence have been more likely to result in default".

As we will see, Breedon and Joyce (1993) provide a theoretical justification for the accumulation of arrears by borrowers and the possession of property by lenders under conditions of falling nominal house prices. Higher rates of possession may then in turn cause a further fall in the nominal house price by reducing the effective demand for housing as households taken into possession are unlikely to be allowed to immediately re-enter the owner occupied housing market. This possessions-house price spiral could clearly serve to prolong any housing market slump (such as that observed during the early 1990s).

The boom and recession in the housing market continue to have a marked impact upon the UK economy, especially through their effect on households which found themselves unable to service the levels of mortgage debt incurred during the second half of the 1980s. This failure of many households to maintain their mortgage repayments led to the rapid increase in the number of dwellings taken into possession.



The chapter is organised as follows. The next section reviews the theoretical model proposed by Breedon and Joyce (1993) (hereafter referred to as B&J) in which equations are derived for house prices, the probability of arrears and the probability of possession. Section 4.3 then discusses the empirical specification of the model and considers the data issues involved. Results are then presented and comparisons made between the findings of this research and those of other studies. The final section then summarises the findings and draws conclusions.

## 4.2 THE THEORETICAL MODEL

### 4.2.1 The Determination of House Prices

The model of house price determination is based on an 'asset market' approach in which housing provides a flow of services and acts as an asset for investment purposes. The model advocated by B&J is based on papers by Dougherty and Van Order (1981), Poterba (1984), Ermisch (1984) and Meen (1990a) amongst others. Although there is no consideration of risk in the model, some previous studies in the housing market have found that risk is not helpful in explaining house price movements<sup>12</sup>.

In the absence of a rented sector for housing, it is assumed that the representative household optimises intertemporal utility over housing services (assumed proportional to  $H$ , the stock of housing) and all other consumption goods  $C$ . Lifetime utility may then be written in continuous time as<sup>13</sup>

$$\int_0^{\infty} e^{-\pi t} u(H_t, C_t) dt \quad (4.1)$$

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<sup>12</sup> Gat (1994), for example, considers risk and return in residential property markets and finds that the Capital Asset Pricing Model (CAPM) is not helpful in explaining the relationship between risk and return. However, such results are not surprising given that the portfolio diversification assumption of the CAPM is contrary to the nature of owner occupation in residential real estate markets. In addition, the consumption and investment decisions are not separable for the housing market investor as they are for the capital market investor.

<sup>13</sup> The usual assumptions that the utility function is increasing, twice differentiable and concave in its arguments are made in addition to the existence of an interior optimum.

where  $r$  is the real discount rate. The utility function is maximised with respect to the following household budget constraint

$$g_t X_t + S_t + C_t = (1 - \theta)Y_t + (1 - \theta)iA_t, \quad (4.2)$$

and two equations of motion defining the intertemporal growth of the stock of housing and savings

$$\dot{H}_t = X_t - \delta H_t, \quad (4.3)$$

$$\dot{A}_t = S_t - \pi A_t, \quad (4.4)$$

where  $g_t$  is the real house price,  $X_t$  represents real new gross house purchases,  $S_t$  denotes real saving,  $Y_t$  is real household income,  $A_t$  represents real net non-housing assets,  $i$  is the nominal interest rate at which the household may both save and borrow freely,  $\theta$  is the marginal household tax rate,  $\delta$  is the rate of housing depreciation and  $\pi$  is the rate of general price inflation.

The real user cost of housing is defined (at the optimum) as the marginal rate of substitution between housing services and the composite consumption good<sup>14</sup> and, following B&J, may be derived from the first order conditions of the dynamic optimisation problem as

$$\frac{u_h}{u_c} = g_t [(1 - \theta)i - \pi + \delta - \dot{g}_t / g_t] = R_t, \quad (4.5)$$

where  $u_h$  and  $u_c$  are the marginal utilities of housing and the composite consumption good respectively<sup>15</sup>.

<sup>14</sup> At the optimum, the marginal rate of substitution (MRS) will be equal to the price ratio between housing and the composite consumption good, and therefore the expression for the MRS will simply be a measure of the relative price of home owning to consuming the composite good.

<sup>15</sup> Dougherty and Van Order (1981) define the user cost as, "the amount necessary to bribe a household to give up a unit of housing", which in real terms is measured by equation (4.5).



Dougherty and Van Order (1981) consider a second approach to deriving the real user cost of housing capital, whereby homeowners are viewed as profit-maximising landlords in a competitive market renting units of the housing asset to themselves. The real user cost must then equal this level of “implicit rent” (or the real price paid for the flow of services from a unit of the housing stock per period) defined as  $R_t$  in equation (4.5) above. If we assume a fixed stock of housing,  $R_t$  must adjust to clear the market for *housing services*, whereas the real house price ( $g_t$ ) will adjust to clear the market for *housing capital*. Rearranging equation (4.5),  $g_t$  is determined as

$$g_t = \frac{R_t}{[(1 - \theta)i - \pi^e + \delta - \dot{g}_t^e / g_t]} \quad (4.6)$$

It is useful to note that it is the *expected* level (denoted by superscript  $e$ ) of future general price inflation and house price appreciation rather than their actual values that are important in determining the current real house price. A number of procedures have been suggested in the past for modelling expected future house price appreciation, ranging from simple naive models (such as  $\dot{g}_t^e = \dot{g}_t$  or  $\dot{g}_t^e = \dot{g}_{t-1}$ ) to more complicated distributed lag functions of current and past actual values such as autoregressive moving average models (the latter of which is undertaken later in the thesis).

Following Meen (1990a) it will prove informative (given the discussion in the previous chapter on the effect of inflation on housing demand) to examine the response of real house prices to inflation. Setting the denominator of equation (4.6) equal to  $J_t$  for convenience and defining  $\dot{P}_{Ht}^e = \dot{g}_t^e / g_t + \pi^e$  as the expected nominal capital gain on housing, we may differentiate  $J_t$  with respect to expected inflation to give

$$\frac{dJ_t}{d\pi^e} = (1 - \theta) \frac{di}{d\pi^e} - \frac{d\dot{P}_{Ht}^e}{d\pi^e} \quad (4.7)$$

We could expect both differential terms on the right hand side of equation (4.7) to equal unity in the long run<sup>16</sup> implying that an increase in inflation leads to a reduction in  $J_t$ . Analysing the dynamics, with a fixed short run stock of housing capital,  $R_t$  will initially remain unchanged. However, the increase in inflation will lead to an increase in real house prices (as shown in equation (4.7)) which in the long run will encourage a rise in the stock supply of housing (assuming non-negative price elasticity of supply) and the ensuing fall in  $R_t$  will mitigate to some extent the initial increase in the real house price.

The specification of the house price equation of (4.6) above only holds when households are not constrained from borrowing in the credit markets. If mortgages are rationed, then higher notional housing demand resulting from, say, a fall in the real user cost of housing capital may not be transformed into higher effective demand. In the presence of differential rates of interest on borrowing and lending, Dougherty and Van Order (1981) and Ermisch (1984) both show that binding constraints on total mortgage borrowing have the effect of increasing the real user cost of housing capital. The user cost in this case is revised upwards by the product of the real house price and the ratio of the shadow price of the rationing constraint ( $\lambda$ ) to the marginal utility of the composite good ( $u_c$ ), the real house price equation then becoming

$$g_t = \frac{R_t}{[(1-\theta)i - \pi^e + \frac{\lambda}{u_c} - \dot{g}_t^e / g_t + (\delta + \kappa + \tau)]} \quad (4.8)$$

where the analysis is expanded to include property taxes ( $\kappa$ ) and transactions costs ( $\tau$ ) which may be shown to appear as specified in equation (4.8) above. Clearly, in unrationed periods this constraint will be slack, forcing  $\lambda$  to be zero (from the complementary slackness conditions of the Kuhn-Tucker conditions).

<sup>16</sup> Poterba (1984) performs simple tests to measure the responsiveness of the nominal mortgage interest rate to expected inflation, finding that the hypothesis  $di/d\pi^e=1$  cannot be rejected over the sample period 1960 to 1980 for the US.



We may now examine how mortgage market constraints affect the response of real house prices to inflation by conducting a similar analysis to that of presented in equation (4.7) above. Redefining  $J_i$  as the denominator of equation (4.8) we may write

$$\frac{dJ_i}{d\pi^e} = (1 - \theta) \frac{di}{d\pi^e} - \frac{d\dot{P}_{Ht}^e}{d\pi^e} + \frac{d(\lambda / u_c)}{d\pi^e} \quad (4.9)$$

Unlike equation (4.7), the introduction of mortgage lending constraints means that the sign of equation (4.9) (and thus the effect of inflation on real house prices) will depend on how inflation affects the rationing constraint. The ratio of the shadow price of the rationing constraint to the marginal utility of the composite good ( $\lambda / u_c$ ) is a purely theoretic concept; thus in the empirical work appearing later in this chapter, the ratio is ignored partly because it is unmeasurable and partly because we are unsure of how it is affected by inflation. The issue of mortgage rationing and its effect on the estimation of an empirical model of the demand for and supply of mortgage finance is addressed in more depth in Chapter 7 of this thesis.

Following Bowden (1980), in order to specify empirically an equation for real house prices it is assumed that the demand for housing services by each household ( $i$ ) depends upon permanent income ( $Y_{pi}$ )<sup>17</sup>, the real rental price of housing services ( $R_i$ ) and demographic variables ( $DEM_i$ ). In turn, the real implicit rental price is assumed to be determined by the demand for and supply of housing services. The aggregated demand function for housing services may then be specified as

$$H_i^d = f_d(R_i, Y_{pi}, DEM_i) \quad (4.10)$$

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<sup>17</sup>  $Y_p$  will be dependent on current income, financial wealth, the unemployment rate and other variables that define permanent income. In the estimations which appear in the second half of the chapter, it is assumed that permanent income can be completely described by current measured income and financial wealth.

With the flow of housing services proportional to the fixed stock of dwellings,  $H^{18}$ , the housing services supply function may be written as  $H_t^s = f_s(H_t)$ , which together with equation (4.10) will determine the equilibrium rental price as

$$R_t = f(Y_{pt}, H_t, DEM_t) \quad (4.11)$$

Finally, substituting out for  $R_t$  in equation (4.8) gives the real house price function as

$$g_t = f(Y_{pt}, H_t, DEM_t, [(1 - \theta)i - \pi^e + \frac{\lambda}{u_c} - \dot{g}_t / g_{(t)} + (\delta + \kappa + \tau)]) \quad (4.12)$$

Both B&J and Meen (1990a) point out that the specification of equation (4.12) does not take into consideration the front-loading or tilt effect (as examined in the previous chapter) whereby higher inflation and nominal mortgage interest rates have the effect of raising real debt service burdens and causing cash flow problems during the early years of the mortgage loan. Thus, with higher inflation one would expect a lower demand for owner occupied housing and a commensurate fall in the real house price. B&J suggest that the tilt effect may be accounted for by replacing the real user cost in the real house price equation with a measure of the nominal user cost, although the preferred methodology of this chapter is to keep unchanged the real user cost variable and instead include a measure of general price inflation in the specification. We noted in the previous chapter that the extent to which the tilt effect is a problem depends upon the nature of the mortgage contract. With an index linked contract in which the real level of mortgage repayments remains constant over the lifetime of the loan the concept of front loading becomes redundant. In addition, with perfect capital markets the mortgagor may *simulate* an indexed mortgage by borrowing against future income (which would rise in line with inflation) to meet the higher mortgage interest repayments. However, the fact that indexed mortgages have been met with little enthusiasm by mortgage borrowers and that capital markets are far from perfect

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<sup>18</sup> In a full model of the housing market  $H$  would be endogenous. The fact that this model has a fixed supply side can be considered as a serious drawback, and thus scope exists for incorporating a supply side for the housing stock in future work.



implies that the tilt problem should remain an important feature of housing demand and therefore will have an effect on real house prices.

Finally, both B&J and Joyce and Kennedy (1992) discuss the nature of the interaction between house prices and the flow of households into possession. Possessions are alleged to have a depressing effect on house prices as possessed households temporarily withdraw from the owner-occupier housing market. With no rented sector, housing supply cannot fall as a result of possessed houses being transferred to the rented market<sup>19</sup> but may be reduced if one believed that where households faced possession the depreciation rate on the dwelling accelerated, or if lenders temporarily held the possessed properties prior to resale. However, these supply considerations are assumed to be outweighed by the effect on demand and thus the ratio of the flow of possessions to the housing stock is unequivocally expected to reduce house prices by putting downward pressure on the demand for owner occupier housing. The final real house price specification is then given as

$$g_t = f_1(Y_{pt}, H_t, DEM, [(1 - \theta)i - \pi^e + \frac{\lambda}{u_c} - \dot{g}_t^e / g_t + (\delta + \kappa + \tau)], POSS_t / H_t, \pi_t) \quad (4.13)$$

#### 4.2.2 The Determination of the Stock of Arrears

The model of Brookes *et al* (1994) is proposed by B&J to determine the stock of mortgage arrears. Following the optimal choice of owner occupied housing<sup>20</sup>, it is assumed that the representative household with zero savings receives a *full* mortgage of amount  $M$  at a nominal interest rate of  $r_m$  (as long as the lender's prudential criteria

<sup>19</sup> The simplification of no rentable accommodation implies that households whose property has been possessed must be assumed to merge with other households. There is certainly scope to include a rented sector in this model and observe how the theoretical and empirical results are affected. One consideration when a rented sector is included is that a rise in possessions would cause an expansion in demand for rented sector accommodation, which would serve to raise the relative costs of renting to home owning.

<sup>20</sup> It is assumed here that the optimal level of housing demand is determined by the optimisation problem as set out in equations (4.1) to (4.4) of Section 4.2.1. In the model of Brookes *et al* (1994), households are assumed to choose their preferred level of housing to maximise a weighted expected utility function in which there is a trade-off between the benefits of additional housing and the costs of defaulting on the mortgage loan.

are met). If in the future the market house price of household  $i$  ( $P_{Hi}$ ) exceeds the value of the mortgage ( $M_i$ ) then there is said to exist unwithdrawn equity in the property and additional finance can be raised by remortgaging. It is thus argued by Brookes *et al* (1994) that a household will face repayment problems if

$$Y_{di} - r_m M_i + \max\{0, P_{Hi} - M_i\} < 0 \quad (4.14)$$

where  $Y_{di}$  is the household's disposable income (i.e. net of what Brookes *et al* (1994) term 'priority cost of living expenses') and  $(P_{Hi} - M_i)$  is unwithdrawn equity<sup>21</sup>. Inflation is introduced by assuming that it affects all variables (with the exception of the mortgage stock) at a rate of  $\pi$ . The real mortgage interest rate,  $\rho_m$ , is determined by the Fisher equation, i.e.  $(1 + \rho_m) = (1 + r_m) / (1 + \pi)$ , which may be rewritten for the nominal rate of interest as  $r_m = (\rho_m + \pi + \rho_m \pi)$ .

It is assumed that a lender will be prepared to offer additional mortgage finance to the borrower on the basis of the amount of unwithdrawn equity in the property, and specifically an additional loan of up to  $\alpha(P_{Hi} - M_i)$  will be made, where  $0 \leq \alpha \leq 1$  depends upon the lender's willingness to engage in additional mortgage lending<sup>22</sup>. Three cases are considered:  $\alpha = 0$ ,  $\alpha = 1$  and  $0 < \alpha < 1$ .

- No additional mortgage lending granted on the basis of  $(P_{Hi} - M_i)$ :  $\alpha = 0$

When mortgage lenders are completely unwilling to grant new loans on the basis of unwithdrawn equity, the arrears condition of equation (4.14) will become

$$Y_{di} - r_m M_i < 0 \quad (4.15)$$

<sup>21</sup> Equation (4.14) is slightly different to that presented in Brookes *et al* (1994) and B&J, where unwithdrawn equity appears simply as  $(P_{Hi} - M_i)$ . Inclusion of the maximum term in the specification above recognises that although positive equity may be a source of additional income for the household (acting as collateral for an extension to the mortgage loan), negative equity does not constitute an outgoing expenditure (except under distressed sale).

<sup>22</sup> This in turn will depend upon the lender's desire to ration mortgages either for prudential reasons or to reduce the problems of moral hazard on the part of the borrower (see Chapter 7 for a full discussion of the motivation for rationing mortgage credit through variations in the loan to value ratio).



In the presence of inflation, we may use the Fisher relation to rewrite this revised arrears condition as

$$(1 + \pi)Y_{di} - (\rho_m + \pi + \rho_m\pi)M_i < 0 \quad (4.16)$$

or

$$(1 + \pi)[Y_{di} - \rho_m M_i - \pi M_i / (1 + \pi)] < 0 \quad (4.17)$$

In other words, households unable to raise additional finance on the basis of unwithdrawn equity have to make an additional 'inflation induced' payment of  $\pi M_i / (1 + \pi)$  (i.e. in addition to the  $\rho_m M_i$  already made), equivalent to the amount by which the mortgage could be increased without the borrower becoming any worse off. Inflation may also be shown to cause a rise in the debt service ratio; in the absence of inflation, the debt service ratio is simply

$$DSR = \rho_m M_i / Y_{di} \quad (4.18)$$

since  $r_m = \rho_m$  when  $\pi = 0$ . Allowing for inflation, as we do in equation (4.16), the debt service ratio becomes

$$DSR(\pi) = [(\rho_m + \pi + \rho_m\pi)M_i] / [(1 + \pi)Y_{di}] \quad (4.19)$$

which will be larger than  $DSR$  since  $\rho_m < (\rho_m + \pi + \rho_m\pi) / (1 + \pi)$  when  $\pi > 0$ . Increases in inflation causing nominal interest rate rises could therefore be expected to have significant effects upon the household's debt service ratio (and therefore the probability of arrears), these effects rising as the ratio  $M_i / Y_{di}$  increases.

- Additional mortgage lending granted to the full extent of  $(P_{Hi} - M_i) : \alpha = 1$

If agents are allowed to use the full extent of the unwithdrawn equity in their property as collateral against additional mortgage borrowing (which is assumed free of any non-interest rate costs), then inflation will have no effect on either the arrears

condition of equation (4.14) or the debt service ratio. The reason for this is that if house prices grow at the rate of inflation, then the borrower may increase the mortgage loan at the same rate. Thus the term representing unwithdrawn equity will grow at the rate of inflation, which is in line with the rate at which the other variables in the inequality are rising. As such, the arrears condition will be unaffected by inflation.

- Additional mortgage lending granted as a percentage of  $(P_{Hi} - M_i) : 0 < \alpha < 1$

With house prices rising at the rate of inflation, the borrower can attain  $\alpha[\max\{0, P_{Hi}(1 + \pi) - M_i\}]$  in additional mortgage finance from the mortgage lender whereas there is an additional finance requirement of  $\pi M_i$ . This implies that there is a shortfall of  $\pi M_i(1 - \alpha)$  assuming that initially  $P_{Hi} = M_i$  (and of course that there subsequently exists positive unwithdrawn equity in the property).

The important question is how does the model of Brookes *et al* (1994) suggest we should empirically model the incidence of arrears in the market for mortgage finance? The above analysis would suggest that if  $\alpha$ , the loan to value ratio on unwithdrawn equity, is strictly less than unity, then inflation will always have an effect on the debt service ratio for the household and thus also on the likelihood of arrears; as such, B&J make use of the debt service ratio explicitly to account for the effect of inflation on arrears. In fact, the use of the debt service ratio in the empirical model of arrears has a dual purpose : not only does it take into consideration the effect of inflation on the probability of default but also accounts for changes in the rate of mortgage interest that are not inflation-induced and the resultant impact on the ability of the household to repay the mortgage debt. The arrears condition will also be dependent upon the household's disposable income and the extent to which there exists unwithdrawn equity in the mortgaged property.

Finally, in addition to these variables suggested by the model of Brookes *et al* (1994) discussed above, B&J posit that arrears will depend also on disturbances to personal



income, which are proxied in their model by the rate of unemployment ( $UR$ ). Thus the model of arrears determination which is estimated by B&J is given by

$$ARR = f_2(R(Y_{dt}), P_{Ht} - M_t, DSR_t, UR_t) \quad (4.20)$$

where  $ARR$  is the proportion of mortgage loans in arrear and  $R$  denotes a variable in real terms.

### 4.2.3 The Determination of the Flow of Possessions

In the model of possessions determination, B&J assume that a risk neutral profit-maximising lender will take action to possess a property if the borrower is facing repayment difficulties and

$$P_{Ht} - q_t > \text{Max}_i \{ \partial_{t+i} E_t(P_{Ht+i} - q_{t+i}) + \sum_{n=1}^i \partial_{t+n} E_t(REP_{t+n}) \} \quad (4.21)$$

Equation (4.21) indicates that a mortgage lender will possess a property today if the total current value that may be realised from its immediate sale (net of the costs involved in the action of possession and subsequent sale,  $q$ ) is greater than the maximum expected discounted future resale value of the property (again net of the costs of possession), where  $\partial$  is the discount factor, plus the expected discounted future debt payments remaining ( $REP$ ) to be received from the borrower before the property is possessed<sup>23</sup>.

Based on the inequality above, the empirical model of possessions is specified as follows. Although B&J suggest that the lender's expectations regarding the *change* in house prices should influence the decision to possess, in a long run cointegrating model this is clearly infeasible (given that the change in house prices is stationary). With house prices in *levels* being integrated of order 1, it would be preferable to instead include this series in the cointegrating relationship. However, given that we

<sup>23</sup> The maximum value of  $i$  represents the time period at which the mortgage debt is completely repaid and the lender no longer has the opportunity to possess the property.

have postulated that possessions will reduce house prices (see Section 4.2.1 above), the coefficient on house prices may appear in the possessions equation with a negative sign.

The stock of arrears of over 6 months ( $ARR$ ) is included in the empirical model since it is considered a reasonable indicator of the borrower's ability to repay the mortgage debt in the future. Indeed, equation (4.21) will only be effective (and thus lenders will only want to possess) when the borrower is facing repayment difficulties, thus underlining the critical importance of the arrears variable in the estimation of the possessions equation.

The value of unwithdrawn equity is included in the estimating equation since its existence provides an escape route for borrowers who potentially face repayment problems; positive equity may be realised by the borrower by either the sale or remortgaging of the property, and thus acts to reduce the probability that the lender will need to possess given a deterioration in the financial circumstances of the mortgagor.

Finally, the real mortgage rate of interest ( $R(r_m)$ ) is included in the equation for possessions to account for the fact that the higher are real mortgage repayments, the more likely it will be that the household will default on the mortgage debt and ultimately face possession. The equation for the proportionate flow into possession ( $POSS$ ) may therefore be specified as

$$POSS = f_3(R(r_m), ARR, P_H - M, g_i^e) \quad (4.22)$$

## 4.3 EMPIRICAL INVESTIGATION

### 4.3.1 Data Issues

All of the data used in this chapter pertains to the geographical domain of the UK; for those series related specifically to the mortgage market the data is provided by the



Council of Mortgage Lenders, the membership of which includes the majority of bank and building society mortgage lending institutions in the UK. Data on arrears and possessions are published in *Housing Finance* (the arrears data is split into two categories corresponding to those households with arrears of 6-12 months and those with arrears in excess of 12 months) and are available annually from 1969 and bi-annually from 1982. In their study, B&J interpolate the annual arrears and possessions data to achieve biannual series on the grounds that poor results were observed for the estimated dynamic error correction models when quarterly interpolated data were used. However, given that the majority of variables in each cointegrating relationship are available on a quarterly basis, it would be inefficient to estimate the equations using bi-annual data. Thus in estimating equations for house prices, arrears and possessions, this chapter uses quarterly data (whether the series are interpolated or as observed). Four series in the raw data set were unavailable on a quarterly basis, their descriptions and frequency being listed in Table A4.1.2 of Appendix 4.1. A full description of the interpolation procedure is also given in the appendix.

An additional and particularly important difference between the data set used in this chapter and that of B&J is the length of the time span. Although it is not possible to obtain aggregate arrears and possessions data prior to 1969, all variables used in the cointegrating analysis of this chapter have been collected for the period 1971Q1 to 1995Q4. This represents almost 5 years of additional quarterly data over that collected by B&J, and is significant because the extended data set captures the upturn, peak and subsequent fall in the level of arrears and flow of possessions (whilst that of B&J only reflects the beginning of the rise) and also the unprecedented prolonged fall in both real and nominal house prices (see Figures 4.2 to 4.5 of Section 4.1).

Finally, in contrast to B&J all data in this chapter is seasonally adjusted. The seasonal adjustment procedure used is that of X11 available in the statistical package SAS (see Section 6.3.2 of Chapter 6 for more details) and is based on the technique used by the

US Census Bureau<sup>24</sup>. The benefits of using seasonally adjusted rather than unadjusted data are that we do not need to explicitly account for seasonal unit roots in testing for stationarity nor need we be concerned about the effects of seasonality in the estimation of the long run cointegrating vector (again, for a brief discussion see Chapter 6).

#### 4.3.2 Methodology

The empirical analysis reported in this chapter is based on the two stage procedure as suggested in Engle and Granger (1987). Firstly, the long run cointegrating vectors for real house prices and the number of arrears and possessions as a proportion of the number of outstanding mortgages are estimated. Secondly, the residuals from these estimations are lagged by one period and included as error correction terms in dynamic regressions. The coefficient on the residuals then indicates the speed with which the dependent variable of the cointegrating model adjusts to equilibrium following an exogenous shock. The analysis is undertaken on an equation-by-equation basis rather than as a system in order to maintain comparability with the work of B&J, despite the fact that one may believe there to be grounds for the use of a system approach.

The parameters estimated in the long run cointegrating relationship are particularly sensitive to the choice of estimation technique. There exist a wide variety of regression procedures for cointegrated systems, many of which yield estimates, *t*-ratios and standard errors that vary considerably; a key issue therefore is the appropriate choice of regression procedure.

With regard to this question, it is of course well known that the estimation of long run time series relationships using Ordinary Least Squares (OLS) leads to spurious regression results as conventional significance tests tend to imply a relationship between the dependent and explanatory variables in the model when in fact none may exist (although the estimators will remain consistent, their distributions will be non-

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<sup>24</sup> All series are adjusted using this procedure with the exception of the unemployment rate, which was not available in a non-seasonally adjusted format. The issue of undertaking an estimation on data series which have been adjusted using different procedures is examined later in the thesis.



standard)<sup>25</sup>. This enables us to formulate a clear decision rule for the choice of estimation procedure : the models are estimated using a number of procedures for cointegrated regressions, the preferred methodology being that most resembling the unbiased parameter estimates of the OLS regression. The results of these estimations are reported in Appendix 4.3. On this basis, the preferred methodology for estimating the cointegrating regression is that of Park (1992) and as such is discussed briefly in the following subsection.

#### 4.3.2.1 Park's (1992) Canonical Cointegrating Regression (CCR) Technique

Park's (1992) (CCR) technique is a non-parametric method for the estimation of cointegrating vectors in models in which the variables all follow first order non-stationary processes (i.e. are integrated of order 1). It is shown by Park that there exists a transformation<sup>26</sup> of the integrated series of the cointegrating model such that the standard OLS procedures, when applied to the transformed model, give asymptotically efficient estimators; in effect, conducting the regression on the transformed variables removes the inefficiency of OLS estimation. The asymptotic distributions of the estimators may then be considered normal, which allows us to interpret the standard errors and *t*-statistics in the usual way.

The CCR technique is similar to that developed by Phillips and Hansen (1990), the main difference being that both the data *and* the estimates are transformed in their Fully Modified (FM) procedure (in contrast to Park's procedure which uses standard OLS on the transformed variables).

It is important here to justify the use of Park's CCR procedure over some of the other more popular techniques available for the estimation of long run cointegrating models. Perhaps the most significant advantage over its rivals relates to the efficiency properties of the estimators. By modifying the non-stationary processes of the model using the long run covariance parameters, Park's procedure is able to correct the OLS

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<sup>25</sup> See Phillips and Durlauf (1986) for a formal proof.

<sup>26</sup> The transformations involve making adjustments to the original integrated processes using the stationary components of the models.

estimators for the endogeneity between the regressors and the presence of serial correlation in the disturbances while maintaining the cointegrating relationship. Indeed, by building on the consistency property of the 'static' OLS estimator, Park's methodology will always yield asymptotically efficient estimators<sup>27</sup>. Moreover, it is shown by Montalvo (1995) (using Monte Carlo simulations) that Park's CCR estimator yields vast increases in efficiency over the FM estimator of Phillips and Hansen. Previous studies have also shown that CCR estimators have better small sample properties (in terms of mean square error) than the Johansen estimators (see Cooley and Ogaki (1996) for a brief discussion).

With the least squares procedure playing an important role in the CCR methodology, the advantages of the standard OLS model will also be applicable here, most importantly that the 'super-consistency' property of the OLS estimator should ensure the precision of the CCR estimates. Indeed, the simple theory behind the least squares estimator makes the CCR estimator all the more tractable, particularly when compared to other more complicated procedures. However, while all statistical packages allow least squares estimation, very few provide routines for the transformations as suggested by Park (GAUSS is one exception). As a final point, while the advantages of using the underlying least squares procedure are all apparent, we must also be aware of its drawbacks, in particular that the parameter estimates can be overly sensitive to outlying observations.

### 4.3.3 Estimation Results

#### 4.3.3.1 Testing for a Unit Root in the Data

The Engle and Granger (1987) cointegration theorem requires all variables to be  $I(1)$ . Therefore each of the variables ( $y_t$ ) are tested for the presence of a unit root by using the Augmented Dickey Fuller (ADF) test.

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<sup>27</sup> It is for this reason that a number of studies (see for example Choi and Ahn (1995)) have used the residuals from Park's CCR procedure in devising LM tests for cointegration, as it has been proved that tests on CCR residuals will be free of nuisance parameters in the limit.



This is undertaken by running the OLS regression

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{j=1}^k \phi_j \Delta y_{t-j} + \varepsilon_t \quad (4.23)$$

and testing the null hypothesis that  $\gamma = 0$  (implying the existence of a unit root). We compute two test statistics proposed in Dickey and Fuller (1979, 1981) that may be used in detecting whether a series has a unit root, and thus whether or not that series is non-stationary.

- *The t-test*

Dickey and Fuller (1979) propose the statistic  $\tau$  for testing the hypothesis  $H_0: \gamma = 0$  (implying the existence of a unit root) which is given by the  $t$ -ratio on the coefficient of  $y_{t-1}$  in equation (4.23) above (the relevant critical values for the  $\tau$  statistic are given in MacKinnon (1991)). Appendix 4.2 gives details of the results of this test on all variables included in the cointegrating models presented in this chapter. It was found that changing the number of lags ( $k$ ) in the ADF regression substantially altered the outcome of the test, and thus a suitable criterion is required to choose the number of lags. The  $t$ -test is calculated in the appendix not only for the level series but also for the first differences of these series in order to test that the non-stationary series are integrated of order 1 (rather than of order 2 or higher)<sup>28</sup>. Clearly, we would hope to find that the level series are non-stationary and the differenced series stationary.

- *The F-test*

Dickey and Fuller (1981) propose two statistics for testing the hypotheses  $(\alpha = \beta = \gamma = 0)$  and  $(\beta = \gamma = 0)$  in equation (4.23). The relevant critical values for the  $F$ -statistics described above are given in Dickey and Fuller (1981) p1063, and the test is conducted by performing a simple variable deletion test. Because the  $F$ -test is not as widely used as the  $t$ -test for testing for a unit root (and tends to lead to the same

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<sup>28</sup> See Dickey and Pantula (1987) for a more formal discussion of this approach.

conclusions) only the results of the above  $t$ -test are presented in Appendix 4.2 (again, it was found that the outcome of the  $F$ -test was highly sensitive to lag length).

There are many techniques suggested in the literature which may be used to decide upon the truncation lag ( $k$ ) in the ADF specification of equation (4.23). One paper in particular which investigates the issue of the correct choice of lag length is that of Ng and Perron (1995). Their paper shows that 'deterministic rules' relating the truncation lag to the sample size,  $T$ ,<sup>29</sup> are inferior to so called 'data dependent rules', a number of which are considered below.

Data dependent rules for the choice of  $k$  are those taking sample information into account and may be further categorised into information based rules and sequential tests for the coefficients on lags. The information based model selection rules select the order of an autoregressive process to minimise an objective function, which in its general form may be written as

$$I_k = \ln(\hat{\sigma}_k^2) + kC_T / T \quad (4.24)$$

where  $\hat{\sigma}_k^2$  is an estimate of the error variance when the model contains  $k$  lags and  $C_T$  is a function satisfying the condition that  $C_T > 0$  and  $C_T / T \rightarrow 0$  as  $T$  tends to infinity. The Akaike Information Criterion (AIC) (1974) is obtained as a special case of equation (4.24) above, where  $C_T = 2$ , whereas the criterion suggested by Schwartz (1978) specifies  $C_T = \ln T$ . These are perhaps the most popular, although it should be noted that other criteria do exist (such as the Rissanen and Hannan and Quinn (1979) Information Criteria). The results of the Schwartz, Hannan-Quinn and Akaike information criteria are presented in Appendix 4.2.

The sequential test is a general-to-specific modelling strategy that chooses between a model with  $m$  lags and one with  $m+n$  lags. The strategy suggests that one should

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<sup>29</sup> Ng and Perron (1995) refer to an example of a deterministic rule formulated by Schwert (1989) in which the truncation lag,  $k$ , is chosen according to the rule  $k = \text{int}\{c(T/100)^{1/d}\}$ , where  $c$  and  $d$  are given constants.



begin with a model of high order, gradually decreasing the lag length until the coefficient on the truncation lag is tested to be significantly different from zero. Formally, we may write this as

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \phi_1 \Delta y_{t-1} + \dots + \phi_k \Delta y_{t-k} + \varepsilon_t \quad (4.25)$$

$$H_1: \phi_k = 0$$

$$H_2: \phi_k = \phi_{k-1} = 0$$

$$H_3: \phi_k = \dots = \phi_1 = 0$$

None of these tests, however, are particularly reliable for determining the optimum number of lags in the dependent variable for the ADF test. In this chapter the preference is to use the straightforward and popular Lagrange Multiplier (LM) test. The original ADF specification of equation (4.23) is estimated by OLS, the residuals ( $\hat{\varepsilon}_t$ ) are saved and we run the regression

$$\hat{\varepsilon}_t = \alpha^* + \beta^* t + \gamma^* y_{t-1} + \sum_{j=1}^k \phi_j^* \Delta y_{t-j} + \sum_{s=1}^p \xi_s \hat{\varepsilon}_{t-s} + u_t \quad (4.26)$$

This provides the basis of a simple test for serial correlation in the ADF model. It can be shown (see Breusch (1978) and Godfrey (1978)) that from this regression the statistic  $TR^2$  is distributed as a chi-square with  $s$  degrees of freedom (where  $s$  is the number of lags of the residuals in regression equation (4.26)) under the null hypothesis of no serial correlation<sup>30</sup>. Then the number of lags to be chosen in the ADF equation is the minimum number at which the null hypothesis cannot be rejected. The logic behind this test is that if any fit is found in the residual regression it must be due to correlation between the current and lagged residuals. The results of this test are also included in Appendix 4.2.

<sup>30</sup> Given the use of quarterly data one may prefer the number of lagged residual terms included in the regression to be at least four. However, the difficulty in the choice of the number of lags in the residuals in equation (4.26) represents a potential problem which, as Greene (1993) notes, "pervades the literature".

All variables used in the models estimated below are found in Appendix 4.2 to be integrated of order 1, although for those series for which the ADF results are not clear a graphical examination of the time series and their autocorrelation functions is performed.

#### 4.3.3.2 Results from the Estimation of Long Run Cointegrating Vectors

The results of the estimation of the three long run relationships for real house prices, arrears and possessions using Park's (1992) CCR technique are presented and discussed in this section. The specification of each equation differs slightly from that of B&J and all models are presented both with and without constant terms<sup>31</sup>; in fact, only in the long run arrears equation is the coefficient on the intercept term not significant at the 5 per cent level.

For each model, preliminary estimations are undertaken according to the methodology developed by Johansen (1988) in order to test for the existence of at least one cointegrating vector among the variables of that model. The Johansen technique is based on the estimation of a vector autoregressive model (or VAR) in differences in which the vector of long run cointegrating variables is included. Under the null hypothesis that there are at most  $r$  cointegrating relationships among the set of non-stationary variables, the parameter vector on these variables in the VAR will have a rank of  $r$  (i.e. it will have  $r$  independent rows)<sup>32</sup>. The choice of lag length in the VAR is governed by data dependent rules such as the Akaike Information Criterion and the Schwartz Criterion (see Section 4.3.3.1 above for details). To avoid repetition of the full methodology, the interested reader is directed to Section 7.2.4 of Chapter 7 of this thesis.

The long run cointegrating real house price relationship is presented below in Table 4.1 with  $t$ -statistics shown in parentheses. Johansen estimations indicate that there are between 2 and 4 cointegrating vectors (depending on whether the Akaike or Schwartz

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<sup>31</sup> Complete tables of results for all three equations using a number of estimation techniques over differing sample periods are presented in Appendix 4.3.

<sup>32</sup> The test is undertaken at the 5 per cent level of significance.



criterion is used to determine the lag length of the VAR) among the set of variables in the proposed house price equation.

**Table 4.1 : Estimates of the Long Run Cointegrating Real House Price Equation**  
Dependent Variable :  $\ln R(PAHM)$

	With Constant	Without Constant
Constant	-15.7793 (-9.79)	
$\ln R(AIJJ)$	-0.3750 (-0.90)	0.1858 (0.40)
$\ln R(ALDO)$	0.3118 (3.63)	0.5664 (4.56)
$\ln DSTK$	1.6619 (2.93)	-0.8708 (-1.72)
$\ln POPN$	1.6365 (7.94)	1.0941 (3.63)
$R(UC)$	0.0104 (1.67)	0.0215 (2.03)
$\ln INFL$	0.1312 (5.25)	0.1507 (3.97)
$\ln POSS$	-0.2256 (-6.36)	-0.0041 (-0.14)
Sample	1971Q1-1995Q4	1971Q1-1995Q4
<i>t</i> -statistics in parentheses		

where  $\ln$  represents the natural logarithm<sup>33</sup> and  $R$  the real value of a variable<sup>34</sup>,  $PAHM$  is a mix adjusted owner occupier house price index (see Section 4.1 for details of the mix adjustment),  $AIIJ$  is personal disposable income (£m),  $ALDO$  represents total personal net financial assets (£m),  $DSTK$  is the stock of owner occupied dwellings (thousands),  $POPN$  is the percentage of the population aged between 25 and 29,  $R(UC)$  is the real user cost of owner-occupied housing capital as a percentage (for details of the construction of this variable see Section 6.4.3.5 of Chapter 6),  $INFL$  is the percentage rate of inflation and  $POSS$  is the ratio of the flow of possessions during the period to the number of outstanding mortgage loans at the end of the period.

<sup>33</sup> Where possible, the natural logarithm of a variable is taken since the use of logarithms in the estimation allows us to interpret the coefficients as elasticities.

<sup>34</sup> Real variables are at 1990 prices and have all been deflated by the consumers' expenditure price deflator with the exception of  $R(UC)$  which is specified as a percentage of the real house price.

It is important to consider how the specification of the relationship has been altered from that estimated by B&J. Firstly, B&J argue that to account for the effect of the tilt or front loading problem on real house prices (see Chapter 3 for a discussion of the tilt problem) the user cost should be included in the estimation in its *nominal* form. Rather than follow this route it is argued here that the real user cost should remain in the estimation with the rate of inflation included as an additional explanatory variable to capture the effect of front loading on the house price. In addition, the nominal user cost variable is found to be stationary in B&J's analysis and thus is included as an additional  $I(0)$  variable in their estimations, its stationarity precluding it from forming part of the long run cointegrating vector. In this chapter we argue that the real user cost variable is integrated of order 1 allowing us to include it in the estimated long run relationship.

Secondly, B&J do not include a measure of possessions in their cointegrating relationship on the dubious grounds that, "the possessions variable was not necessary to form a cointegrating vector". It is hypothesised in Section 4.2.1 that possessions should be important in the determination of real house prices and as such are included here as a proportion of the number of mortgage loans outstanding.

Finally, in all equations B&J do not explicitly distinguish a constant term in their long run cointegrating vectors<sup>35</sup>. From Table 4.1 above, the results appear particularly sensitive to the inclusion of a constant term in the estimation. In discussing the results of the house price equation we will concentrate on the estimation in which a constant term is included since one might expect its exclusion to cause misspecification problems; this is confirmed by considering Figure 4.6 below of the residuals of the two estimations. In addition, the constant term is shown to be highly significant.

The autocorrelation functions for the residuals of the equations in Table 4.1 are presented in Figure 4.7 below. For both equations, the function drops quickly to zero

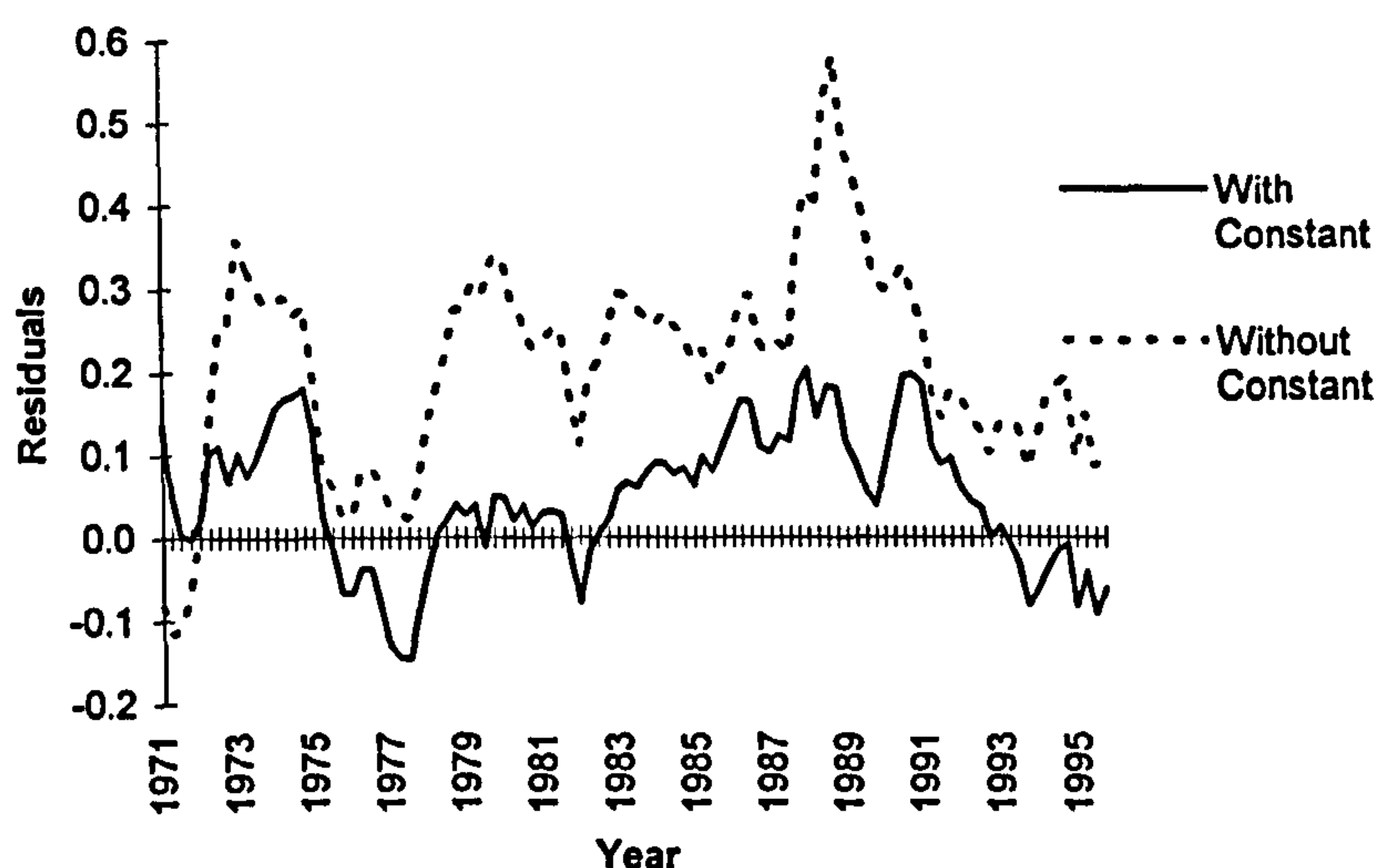
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<sup>35</sup> Given that B&J use the Johansen (1988) methodology to estimate their cointegrating relationships, the constant term will appear only in the short run dynamic equations. Without appropriate restrictions, it is then impossible to partition the constant term between the cointegrating vector and the short run dynamic model. This issue is discussed more fully in Chapter 7.

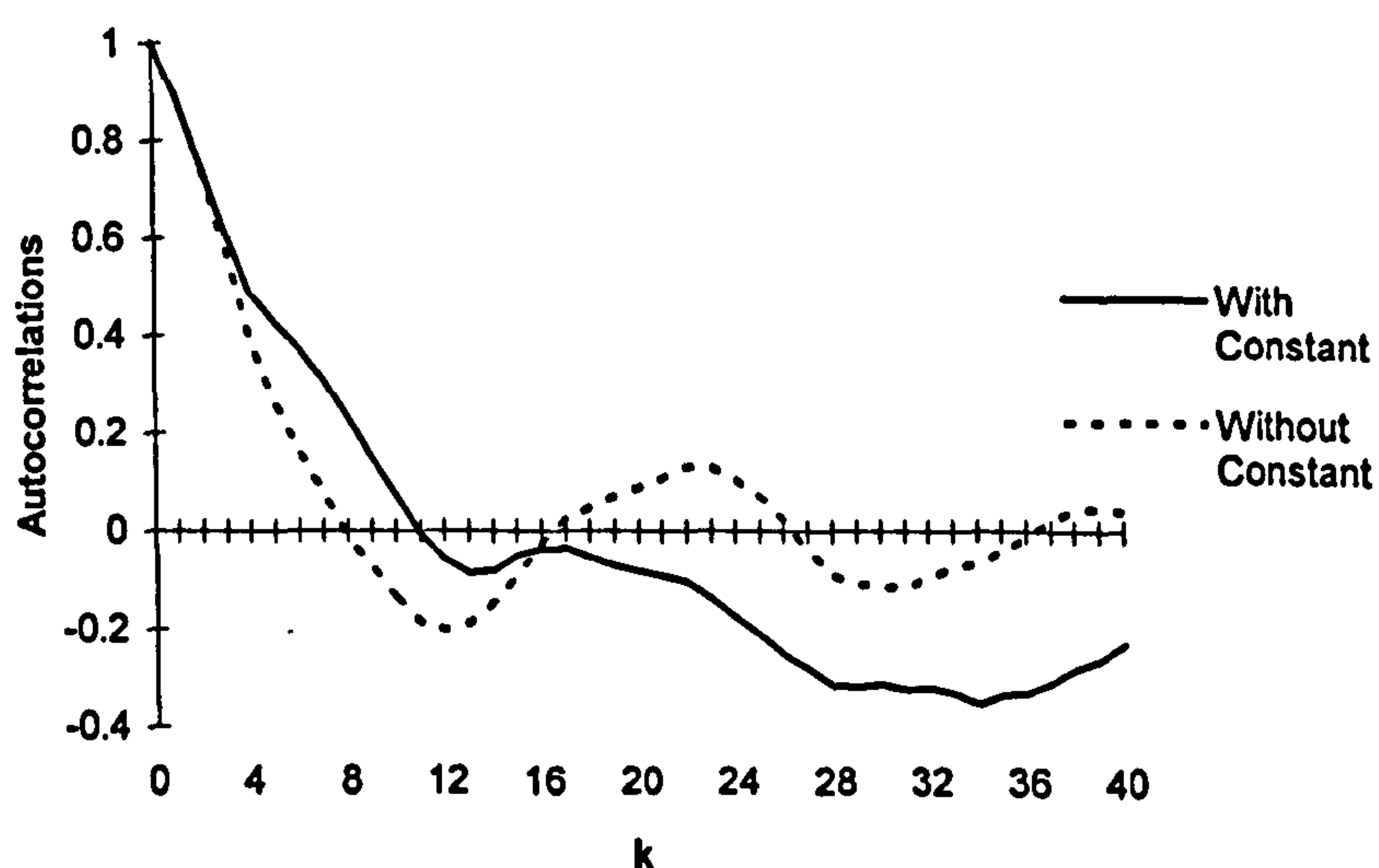


as we increase the number of lags ( $k$ ) indicating that the residuals are stationary and that the model estimated is indeed one of cointegration.

**Figure 4.6 : Residuals of Park's (1992) CCR Estimation of Real House Prices**



**Figure 4.7 : Autocorrelation Function for the Residuals of the Cointegrating House Price Equation**



Real personal disposable income was found to be insignificant in the real house price estimation and entered the equation specified with a constant with the wrong sign. In the equation without a constant, real house prices were found to react inelastically to

changes in real personal disposable income, with a 1 per cent increase in real income leading to only a 0.19 per cent increase in the real price of housing in the long run. However, given the insignificance of the coefficients we clearly cannot draw any firm conclusions from these results.

Nevertheless, there is a reasonable explanation for the poor performance of the real income variable in the results reported above. When the house price specification of Table 4.1 is estimated over a similar sized sample to that used by B&J (i.e. from 1971Q1 to 1990Q3) the coefficient becomes positive and highly significant in both specifications (see Appendix 4.3 for details), in line with our *a priori* expectations. In fact the coefficient turns out not to be significantly different from unity when the equation is estimated with an intercept term, implying that a one per cent rise in real income will, by stimulating the demand for owner occupation, generate a one per cent rise in real house prices. Thus, the main reason for the observed low coefficient presented in Table 4.1 above appears to be the extension of the estimation sample to cover a period in which a sustained fall in real house prices has been accompanied by a (generally) non-declining level of real income. B&J estimate the coefficient on the log of real personal disposable income to be 2.87; indeed, since their model does not contain a constant term, this is broadly consistent with the coefficient of 2.69 reported in Appendix 4.3, obtained from estimating the model above without a constant.

In reality, the true elasticity of the real house price with respect to a change in real personal disposable income is likely to lie somewhere in between the figures discussed above. We should not be surprised if the coefficient were actually greater than unity given that, in general, mortgage lenders will lend a multiple of the borrower's current income. Reilly and Witt (1994), for example, estimate the elasticity to be reasonably low at 1.19 whereas higher elasticities have been reported in Hendry (1984) and Nellis and Longbottom (1981) at 1.78 and 1.85 respectively.

As expected, house prices were positively and significantly related to real financial wealth, with an elasticity of slightly over 0.3<sup>36</sup>. This suggests that the average house

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<sup>36</sup> This result compares with that of B&J who find a coefficient of 0.15 on their real gross financial wealth variable.



price will change (in percentage terms) by around one third of the percentage change in personal sector gross assets as a result of the effect of personal wealth holdings on the demand for housing. However, the coefficients on both  $\ln R(ALDO)$  and  $\ln R(AIIJ)$  must be interpreted with care since the correlation between real financial assets and real personal disposable income as measured by the correlation coefficient was found to be in excess of 0.9. This suggests that the measures of income and financial assets may be capturing a similar effect in the house price equation, which may possibly serve to reduce their explanatory power and size.

Given that the estimated long run house price relationship is essentially a reduced form equation of the demand for and supply of housing, one would have expected that a rise in the stock of owner occupied dwellings would lead to a rightward shift in the supply of owner occupied housing and thus to an equilibrium at a lower real house price (*ceteris paribus*). Curiously, however, an increase in the stock of owner occupied dwellings was found to lead to an *increase* in the real house price<sup>37</sup>. This may reflect the fact that an increase in the supply of owner occupied housing may actually stimulate, or be stimulated by, greater demand; the rise in owner occupation during the 1980s following government policies to increase the availability of owner-occupier housing is a particularly good example. However, this result does contradict the findings of a number of other studies, including that of Hendry (1984) who finds a coefficient on the log of the housing stock of -1.16 in his level house price equation.

Table 4.1 shows that real house prices depend positively on the proportion of the population aged between 25-29<sup>38</sup> (intended as a proxy for the demographic variables, *DEM*, in equation 4.13). The coefficient on this variable is highly significant, suggesting that the higher the proportion of the 'house-buying population' the greater will be potential demand for owner-occupied housing and thus the greater the real house price. Indeed this is confirmed by Mankiw and Weil (1989) who simulate the effects of a 'baby boom' on the real price of housing under two varying assumptions

<sup>37</sup> It may be noted that in the model estimated without a constant term the coefficient was found to be correctly signed and significant at the 10 per cent level.

<sup>38</sup> This is the typical age of first time buyers. This percentage ranges from a minimum of 6.34 per cent in 1971Q1 to a maximum of 8.29 per cent in 1992Q1, with an average over the whole sample period of 7.45 per cent.



about house price expectations in order to show that the boom in demand will have the effect of raising house prices dramatically. Comparisons between studies of the coefficients on demographic variables are difficult for two reasons. Firstly, there are a variety of possible proxies for demography that may be used in the house price equation; Buckley and Ermisch (1981), for example, use the log of net household formation which entered their house price equation with an elasticity of 1.14, whereas Thom (1983) uses the log of the ratio of marriages to private sector completions, finding a considerably lower elasticity of 0.27. Secondly, it has in the past been common practice not to take the logarithm of proportional variables (such as the percentage of the population of house buying age) making the comparison of results across studies even more problematic.

The real user cost of owner occupied housing ( $R(UC)$ ) performed poorly in the model, entering the house price equation with a positive sign, albeit only weakly significant in the 'with-constant' estimation. One would have expected that the higher the real cost of owner occupied housing the lower would be the house price as a result of its impact on demand.

The inflation rate, which was included in order to capture the front loading effect on mortgage demand (and thus also on the demand for and price of owner occupied housing) appears in Table 4.1 with a significantly positive sign. This suggests that the expected negative effect of the front loading problem is significantly outweighed by the positive effects of inflation which serve to encourage home ownership. Equation (4.7) of Section 4.2.1 provides a formal theoretical proof that real house prices will indeed increase when inflation rises, although this conclusion becomes indeterminate when credit market constraints are introduced (see equation (4.9) of the same section).

During times of high inflation, the investment demand for housing will increase if alternative fixed-interest-rate assets fail to maintain their real value. In addition, high inflation has in the past been associated with increased mortgage demand as the real rate of interest on the mortgage loan has fallen (particularly during the 1970s when the operation of the Building Societies Association cartel prevented mortgage rates from



increasing in line with inflation, leading to highly negative real rates of interest). Inflation therefore discourages investment in those financial assets which are not completely indexed and as such encourages borrowing for the purchase of real estate; the resulting increase in the demand for owner occupation therefore has the effect of driving up the real price of housing.

The coefficient on the possessions variable is, as expected, negatively signed and also significant at the 5 per cent level in the preferred equation. As the number of possessions for a given stock of mortgages increases, the demand for housing will fall (as will the real house price) as previous owner occupier households are forced to withdraw (at least temporarily) from the market. In addition, an increase in possessions may serve as a signal for potential borrowers to delay their purchase of owner occupier housing since it may be the case that such an increase is, to some extent, a result of a period of tougher default policy on the part of the mortgage lender (discouraging mortgage borrowing and the purchase of housing and therefore lowering real house prices). Finally, a rise in possessions usually occurs in response to the adverse movement of other macroeconomic variables not explicitly accounted for in the cointegrating regression (such as the unemployment rate) which will act to reduce the demand for owner occupied housing and thus also its price.

Turning to the estimation of the long run arrears equation, Johansen estimations point to the existence of between 2 and 4 cointegrating vectors (again depending on whether the Akaike or Schwartz criterion is used to determine the lag length of the VAR) among the set of variables of the arrears specification.

In Table 4.2 below, *ARR* represents the stock of mortgages in arrears of 6 months or over as a proportion of the total number of mortgages outstanding<sup>39</sup>, *UR* is the percentage unemployment rate, *AYR* is the average loan to income ratio for first time buyers, *UNEW* is an index of the value of unwithdrawn equity in the property

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<sup>39</sup> Brookes *et al* (1994) suggest that the measurement of both arrears and possessions relative to the stock of mortgages outstanding is the best means of gauging how widespread mortgage payment difficulties are, although argue that it may not represent the best method of measuring the social costs associated with such problems. In addition, it should be noted that in contrast to the estimations presented in Table 4.2, Allen and Milne (1994) model arrears as a *flow* rather than as a stock.

(calculated as a ratio of the average house price to the average mortgage loan) and *DSR* is the debt service ratio (calculated as the after-tax mortgage interest rate multiplied by the total value of mortgage loans outstanding as a percentage of personal disposable income)<sup>40</sup>.

**Table 4.2 : Estimates of the Long Run Cointegrating Arrears Equation**  
Dependent Variable : *lnARR*

	With Constant	Without Constant	With Constant
Constant	-0.8646 (-0.18)		16.9203 (2.95)
<i>lnUR</i>	0.1300 (1.17)	0.1043 (1.33)	0.1458 (2.20)
<i>lnR(AIJ)</i>	0.8749 (1.78)	0.8777 (8.58)	-1.0924 (-1.68)
<i>lnAYR</i>	2.3487 (2.93)	1.8982 (3.34)	2.4029 (5.87)
<i>lnUNEW</i>	-2.7139 (-9.45)	-2.9257 (-14.73)	-2.2232 (-10.43)
<i>lnDSR</i>	0.3982 (1.99)	0.5255 (5.94)	1.0307 (4.63)
Sample	1969Q4-1995Q4	1969Q4-1995Q4	1970Q3-1991Q2
<i>t</i> -statistics in parentheses			

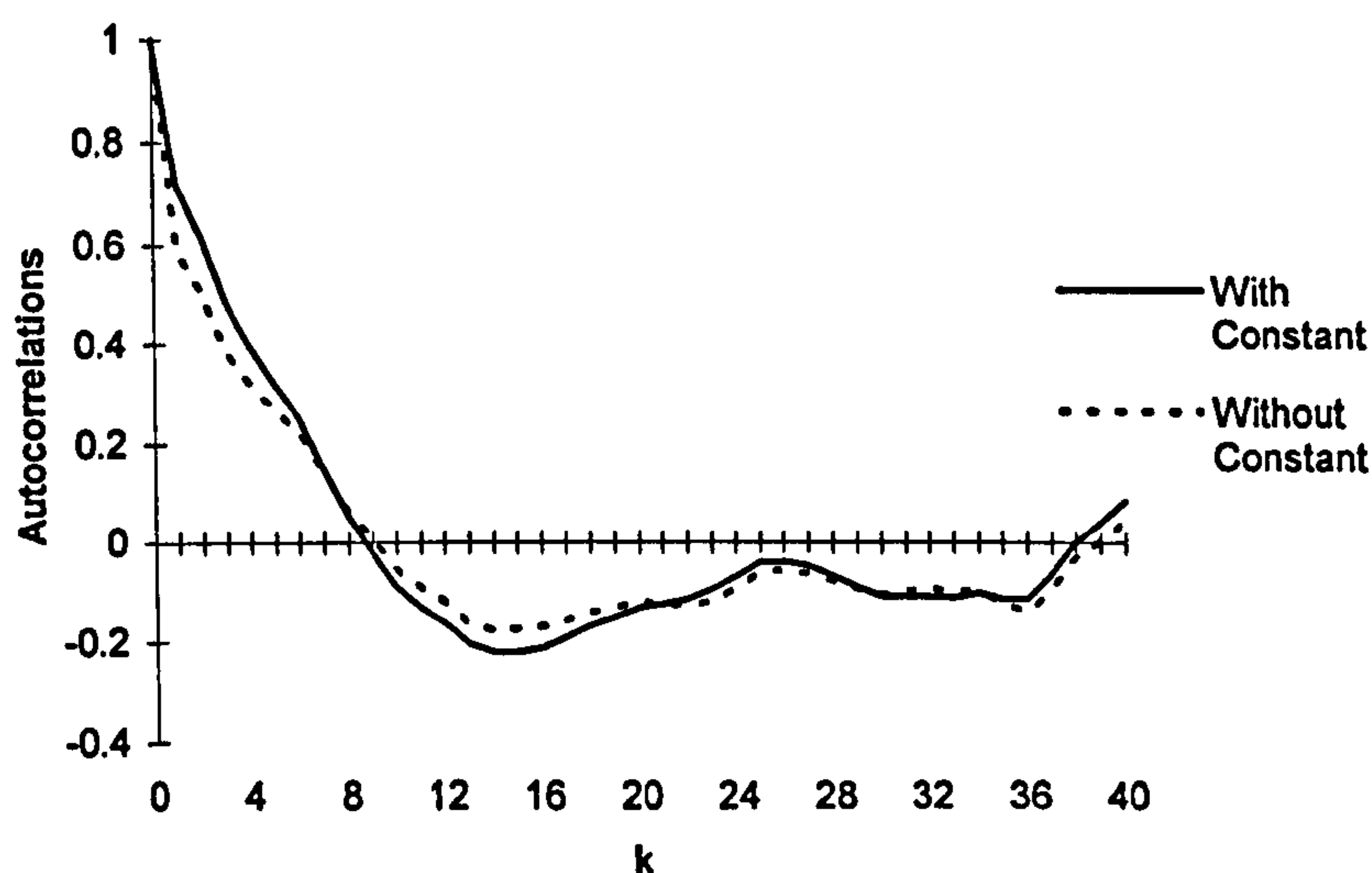
The table above suggests that the arrears equation estimated without an intercept term is preferable to that estimated with a constant; although there is little difference between the size of the estimated coefficients of the two equations estimated over the whole sample period (the first two columns of Table 4.2 above), the *t*-statistics on the coefficients in the no-constant model are in most cases substantially higher.

Given the similarity of the size of the coefficients in the two models, it is not surprising that the residuals from each regression were found to be remarkably similar. The autocorrelation functions for the residuals of the equations presented in the first two columns of Table 4.2 appear below in Figure 4.8. The functions both fall to zero speedily as the number of lags (*k*) is increased, suggesting that the residuals are stationary and that the variables of the estimated models do cointegrate.

<sup>40</sup> The mortgage rate is tax-adjusted by accounting for the effect of the MIRAS scheme.



**Figure 4.8 : Autocorrelation Function for the Residuals of the Cointegrating Arrears Equation**



The incidence of arrears is found to be a positive function of the unemployment rate, although the coefficient on this variable is insignificant for any reasonable choice of critical value. It is usually the case that the decision to purchase a house and the commitment to regular mortgage repayments is made on the basis of continued expected employment of the buyer. An increase in redundancies and layoffs therefore means that more borrowers will be impeded in their ability to make such repayments and will therefore increase the occurrence of arrears. Coles (1992) notes that, “most arrears problems result from relationship breakdown or severe loss of income, or frequently both”, and that according to a telephone survey of the membership of the Council of Mortgage Lenders (CML) in December of 1991, “around 20 per cent to 30 per cent of current arrears problems are associated with unemployment”.

The coefficient on the log of real personal disposable income ( $\ln R(AIIJ)$ ) was found to be positive (and highly significant in the preferred regression) in contrast to our *a priori* beliefs that higher personal disposable income should reduce the incidence of arrears. However, it is interesting to note that if we constrain the estimation period to be the same length as that used in B&J (the results of which are presented in the final column of Table 4.2), then the coefficient on real income becomes correctly signed

and significant at the 10 per cent level<sup>41</sup>. This may imply that the arrears equation as specified in B&J is unstable (Pain and Westaway (1996) also provide evidence to support the contention that B&J's model is unstable out of sample), and likely reflects the fact that real incomes did not fall by as much as one might have expected during the recession of the early 1990s. Dale (1995) confirms that income should have a negative effect on the number of households facing arrears problems, writing that, "future income plus future liquidity, less future debts and liabilities, provide the credit cushion against which a mortgage loan is advanced. Clearly, the larger the cushion, the greater an individual's ability to meet his or her potential obligations".

The loan to income ratio for first time buyers is found to exert a positive and significant influence on the arrears-to-mortgages ratio; the higher is the average mortgage loan relative to personal income the greater will be the chance of default on the repayment of the debt<sup>42</sup>. The debt service ratio is a slightly different measure of the ability of the household to honour its mortgage debt repayments out of current income since it takes into account not only the level of mortgage debt but also the rate of interest on that debt; the coefficient on  $\ln DSR$  is, as expected, positive and significant at the 5 per cent level.

The variable constructed to represent unwithdrawn equity appears negatively and highly significantly in the arrears equation. This suggests that as the average price of owner occupied housing rises relative to the average mortgage loan, there will be a greater potential for housing equity withdrawal either by the owner moving to a smaller dwelling, taking on a second mortgage or by remortgaging. By realising the unwithdrawn equity in the property in this way, the problem of arrears can be ameliorated.

As Brookes *et al* (1994) point out, in a world in which agents are completely rational and have perfect foresight, repayment difficulties should never form part of the

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<sup>41</sup> The critical value for the  $t$ -distribution at the 10 per cent level of significance with 80 observations is 1.664.

<sup>42</sup> Other loan terms may also be expected to influence the level of arrears. Coles (1992), for example, suggests that, "a high loan to value ratio is the most important single characteristic of loans going into arrear and to possession".



equilibrium market outcome. Under such circumstances, households will calculate the current and expected future real costs of servicing the mortgage and will decide not to take on the loan if future mortgage default is inevitable.

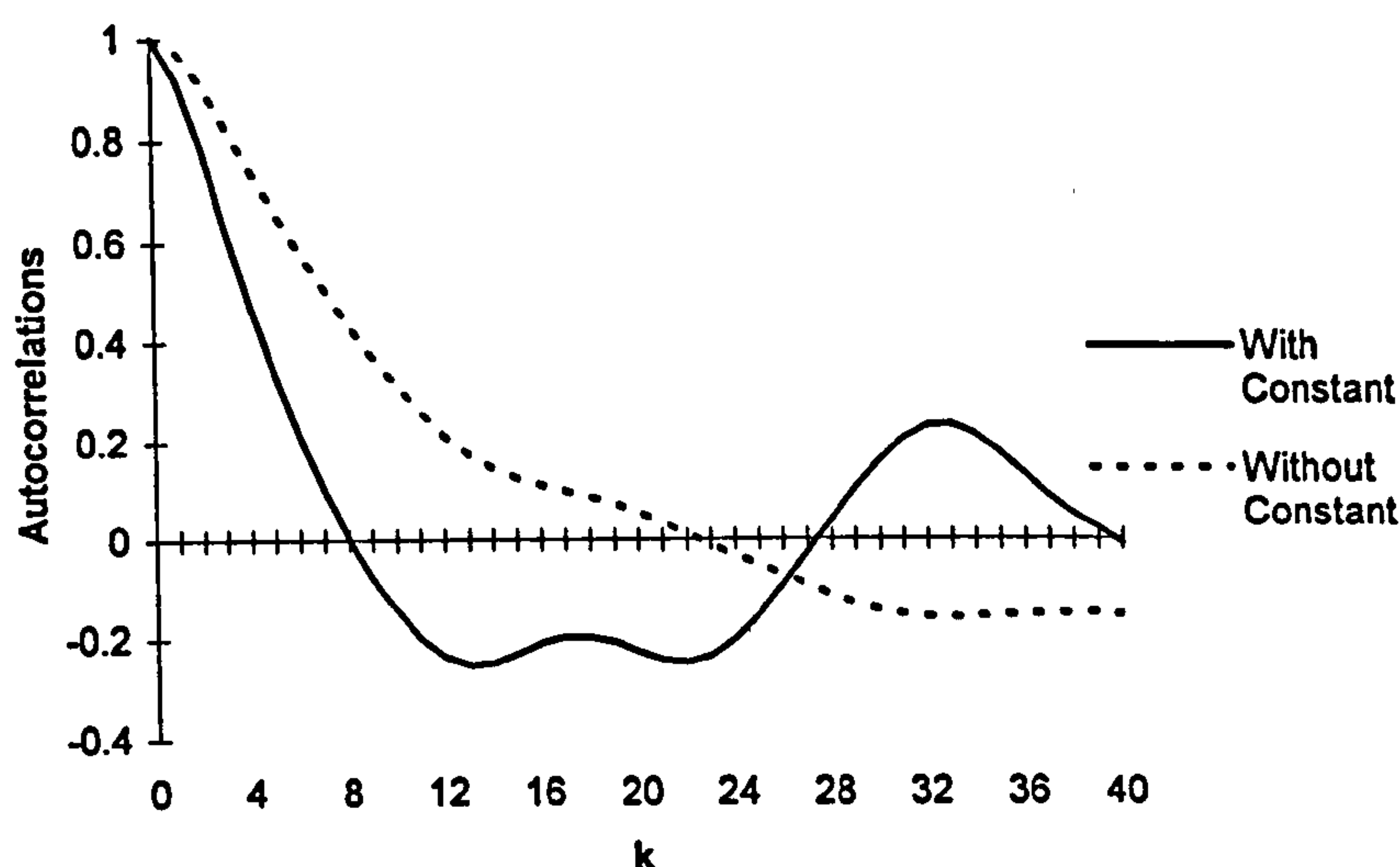
Finally, Table 4.3 below presents the results from the long run estimation of the possessions equation. Prior estimation of the Johansen VAR in differences suggests that there exists 1 cointegrating vector amongst the set of variables in the possessions specification.

**Table 4.3 : Estimates of the Long Run Cointegrating Possessions Equation**  
Dependent Variable :  $\ln POSS$

	With Constant	Without Constant
Constant	-14.3046 (-2.01)	
$\ln ARR$	1.5199 (3.43)	0.7357 (7.42)
$R(r_m)$	0.0114 (0.22)	-0.0189 (-0.49)
$\ln UNEW$	3.0814 (1.25)	-1.5976 (-2.93)
$\ln R(PAHM)$	-0.5768 (-0.51)	1.0056 (1.68)
Sample	1969Q4-1995Q4	1969Q4-1995Q4
<i>t</i> -statistics in parentheses		

where  $R(r_m)$  is the real after-tax percentage rate of mortgage interest and all other variables are as defined previously. The specification differs from that of B&J in the incorporation of the real house price as an explanatory variable in the regression following the specification of equation (4.22). The autocorrelation functions for the residuals of both equations are presented below in Figure 4.9. The functions fall rapidly to zero as  $k$  rises, implying that the residual series are both stationary and that the estimated equations do represent valid cointegrating vectors.

**Figure 4.9 : Autocorrelation Function for the Residuals of the Cointegrating Possessions Equation**



The arrears variable appears positively in the model of possessions, indicating that the greater the proportion of borrowers currently in arrears the greater will be the proportion of borrowers who will be possessed. Given that the possession of property results from the accumulation of arrears the sign of this coefficient is as expected. However, in the equation specified with a constant the elasticity on the arrears variable is greater than 1, which is a curious result given the long run nature of the equation. This would in fact suggest that a 1 per cent increase in the proportion of arrears to mortgages leads to a 1.5 per cent increase in the possessions to mortgages ratio.

The model estimated without a constant term appears to suggest a more plausible magnitude for the elasticity on arrears, indicating that for every 1 per cent increase in the arrears to mortgages ratio, the number of possessions as a proportion of mortgages will rise by around 0.74 per cent in the long run. Thus, on the basis of this result, the specification in which the constant term is excluded is preferred to that estimated with a constant.

As B&J note, the real interest rate term should capture, "the impact of interest rates both on the probability of debt repayment by borrowers and on the opportunity cost of



not possessing for lenders". However, in both specifications presented in Table 4.3 above the interest rate coefficient is insignificant and in the model estimated without a constant is of the wrong sign.

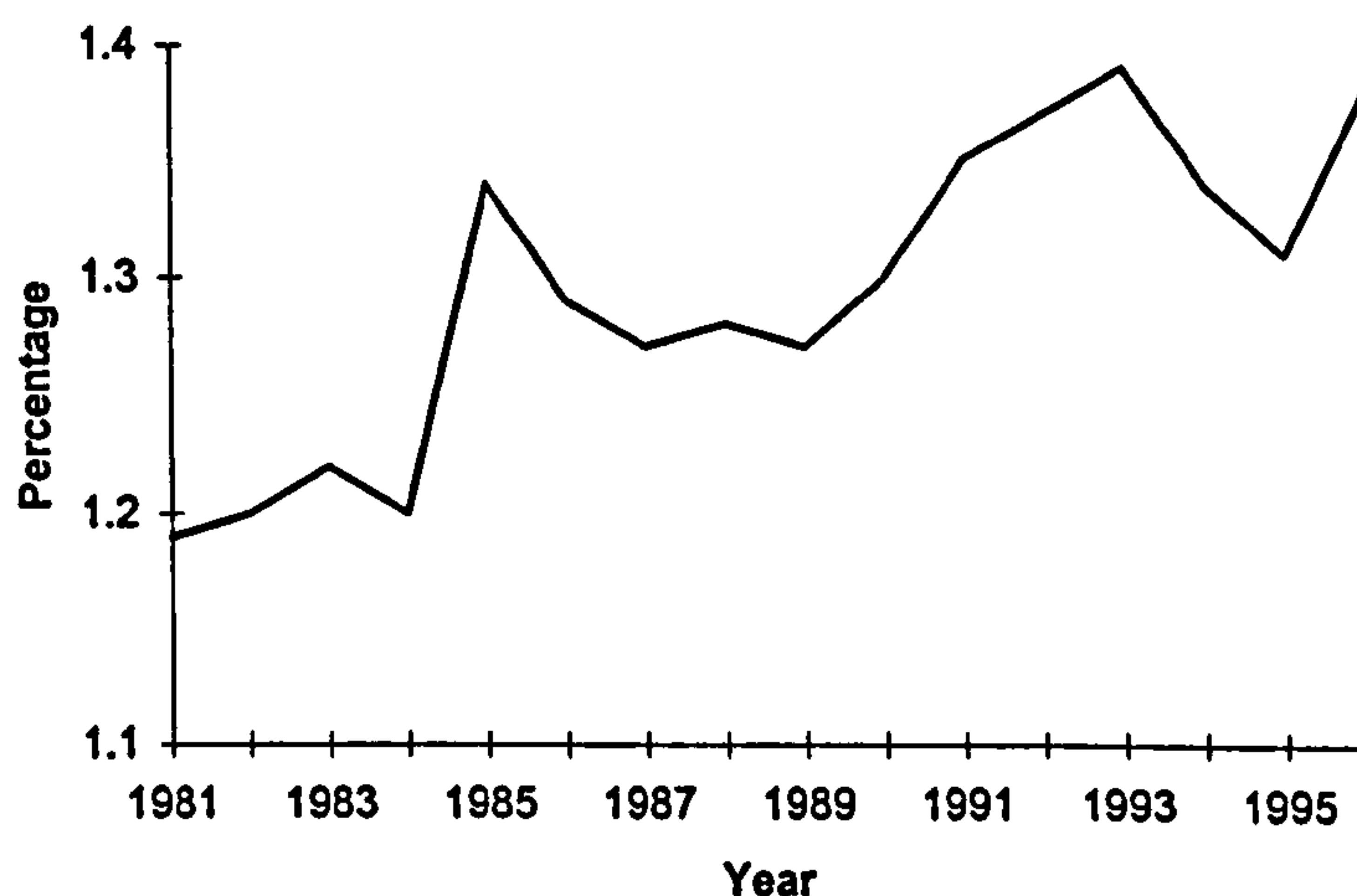
An increase in aggregate unwithdrawn equity in owner occupied housing is found to lead to a reduction in the ratio of the number of possessions to mortgages outstanding for the same reasons as outlined in the discussion of Table 4.2 for arrears. The variable appears significantly and correctly signed in the preferred cointegrating vector of Table 4.3.

The coefficient on house prices enters the preferred possessions model with a positive sign and is significant at the 10 per cent level, indicating that the higher is the real house price the greater will be the ratio of the number of possessions to mortgages. This sign is consistent with theoretical expectations, since according to equation (4.21) of Section 4.2.3, higher current house prices ( $P_H$ ) will increase the benefits to the lender of early possession.

Finally, before moving on it is appropriate to say something about the effect on arrears and possessions of relationship breakdown. Recent survey evidence has pointed to divorce as an important factor in causing households to slip into arrears and ultimately being possessed. In addition to the CML's 1991 survey on the causes of mortgage indebtedness (see previous discussion of the results from the long run arrears estimation), research by the Office of Fair Trading, the Policy Studies Institute and the National Consumer Council have all arrived at similar conclusions : that, "changes in the structure of the household - such as the birth of a baby or the breakdown of a marriage or relationship ... seemed linked to indebtedness" (Anderson (1990)). Coles (1992) also points out that those households most vulnerable to the accumulation of arrears or being taken into possession are young unmarried couples with joint mortgages, a social group particularly prone to relationship breakdown. With the percentage of cohabiting couples rising, this will clearly have had an effect on the rise in arrears and possessions. Indeed, unlike unemployment, rising divorce rates do not tend to be highly correlated with the economic cycle, and thus provide a reason for the

rise in the trend rate of arrears and possessions (Figure 4.10 below charts the rise in the divorce rate). Thus an obvious area for future research would be the inclusion of a variable reflecting relationship breakdown in the long run arrears and possessions equations.

**Figure 4.10 : Decrees Absolute Granted in England and Wales**



#### 4.3.3.3 Results from the Estimation of Short Run Dynamic Equations

The final stage of the Engle and Granger (1987) methodology is the estimation of an error correction model for each long run relationship. These dynamic equations include lagged difference terms in addition to the lagged residual series from the corresponding cointegrating model in order to capture the short run adjustment towards long run equilibrium. The short run dynamic equations for real house prices, arrears and possessions are presented in Table 4.4 below, where  $RESIDS_{HP,t-1}$ ,  $RESIDS_{ARR,t-1}$  and  $RESIDS_{POSS,t-1}$  are the lagged residuals from the cointegrating regressions of Tables 4.1 to 4.3 respectively,  $ZLVF$  is the loan to value ratio for first time buyers (as a percentage),  $\Delta$  indicates the first difference of a variable and Chow 1 and Chow 2 are Chow's (1960) structural stability and predictive failure tests respectively. The number of lags included in the equations are chosen using a general to specific modelling strategy with the maximum number of lags deemed acceptable being four (since we are using quarterly data).



Table 4.4 : OLS Estimates of the Short Run Dynamic Equations

Real House Price Equation Dependent : $\Delta \ln R(PAHM)$		Arrears Equation Dependent : $\Delta \ln ARR$		Possessions Equation Dependent : $\Delta \ln POSS$	
Constant	0.0028 (1.51)	Constant	0.0007 (0.36)	Constant	0.0041 (0.98)
$RESIDS_{HP,t-1}$	-0.1359 (-4.76)	$RESIDS_{ARR,t-1}$	-0.0299 (-2.78)	$RESIDS_{POSS,t-1}$	-0.0209 (-1.85)
$\Delta \ln R(PAHM)_{t-1}$	0.4430 (4.44)	$\Delta \ln ARR_{t-1}$	1.8304 (26.20)	$\Delta \ln POSS_{t-1}$	1.5524 (15.98)
$\Delta \ln R(PAHM)_{t-2}$	0.3801 (3.85)	$\Delta \ln ARR_{t-2}$	-1.5560 (-13.73)	$\Delta \ln POSS_{t-2}$	-0.9471 (-5.97)
$\Delta \ln R(AIJJ)_{t-1}$	0.2884 (2.72)	$\Delta \ln ARR_{t-3}$	0.7119 (10.11)	$\Delta \ln POSS_{t-3}$	0.2091 (1.96)
$\Delta \ln POPN_{t-1}$	1.2735 (4.79)	$\Delta \ln AYR_{t-1}$	-0.3393 (-3.28)	$\Delta \ln ARR_{t-2}$	0.1418 (1.95)
$\Delta \ln INFL_{t-1}$	0.0300 (2.61)	$\Delta \ln UNEW_{t-4}$	0.2268 (2.54)	$\Delta R(r_m)_{t-1}$	0.0059 (1.68)
$\Delta \ln INFL_{t-3}$	-0.0294 (-2.80)	$\Delta \ln DSR_{t-3}$	0.0750 (2.78)	$\Delta \ln ZLVF_{t-3}$	-0.5682 (-1.90)
$\Delta \ln POSS_{t-1}$	-0.1183 (-4.01)				
$\Delta \ln POSS_{t-2}$	0.1317 (3.84)				
$R^2$	0.7885	$R^2$	0.9502	$R^2$	0.8932
Adjusted $R^2$	0.7669	Adjusted $R^2$	0.9464	Adjusted $R^2$	0.8850
LM (Serial Correlation)	2.6100	LM (Serial Correlation)	5.1872	LM (Serial Correlation)	12.3800
Chow 1 (LM)	8.5897	Chow 1 (LM)	9.4752	Chow 1 (LM)	8.5798
Chow 2 (LM)	12.9812	Chow 2 (LM)	13.4489	Chow 2 (LM)	13.8287
Sample	1971Q3-1995Q4	Sample	1971Q2-1995Q4	Sample	1971Q2-1995Q4

*t*-statistics in parentheses

The dynamic real house price equation is presented in the first column of Table 4.4 above. At 13.6 per cent, the coefficient on the lagged residuals from the cointegrating house price equation was found to be significantly higher (at the 5 per cent level) than that presented in B&J and Joyce and Kennedy (1992), although may still be considered fairly low. Indeed, B&J find an adjustment parameter of 6.5 per cent whilst Joyce and Kennedy report a figure of 7 per cent. This suggests that the adjustment of real house prices to their equilibrium level following a shock to either the demand for or supply of housing is reasonably slow (with only 13.6 per cent of the adjustment being made each quarter it will take 5 quarters before more than half of the price adjustment is complete). The most likely reason for this fairly slow adjustment is the presence of significant adjustment costs which will affect households' demand for owner occupied housing.

All of the difference terms in the estimation are significant at the 5 per cent level and the signs are broadly consistent with our *a priori* expectations. An interesting feature of the dynamic model is that the lag structure on the possessions variable suggests that a permanent rise in possessions has only a temporary effect on house prices in the short run. A one per cent rise in the possessions ratio is shown to lead to a 0.12 per cent fall in house prices in the subsequent quarter and a 0.13 per cent rise in the quarter after, suggesting little overall impact of possessions on house prices in the short run. The LM test statistic confirms that residual serial correlation is not a problem in the estimated equation (the critical value of the chi-square distribution at the 5 per cent level with 4 degrees of freedom is 9.49) and the goodness of fit measures are satisfactory. In addition to the regressions for the full sample period presented in Table 4.4 above, the model is estimated over the restricted sample period ending in 1989Q4 (i.e. the period immediately prior to the unprecedented fall in real house prices during the early 1990s) with the remaining 24 observations up to 1995Q4 being used to test for the stability of the estimated parameters and the predictive ability of the model. Structural stability is tested using the Chow 1 test statistic in Table 4.4; at the 5 per cent significance level, the test statistic is less than the critical value ( $\chi^2(10) = 20.48$ ) implying that we may not reject the hypothesis that the regressions of each period (i.e. 1971Q3-1989Q4 and 1990Q1-1995Q4) are the same; we may conclude therefore that the parameters of the estimated equation are intertemporally stable. Likewise, the Chow 2 test confirms the ability of the model to predict the considerable changes in real house prices during the first half of the 1990s using the model estimated up to 1989Q4 (the critical value at the 5 per cent level of significance of the chi-square distribution with 24 degrees of freedom is 36.42). The robustness of these findings is interesting in the light of recent work undertaken by Muellbauer and Murphy (1997) who find that the parameters of their house price equation undergo significant shifts as a result of the financial liberalisation of the 1980s and 1990s.

The dynamic equation for arrears includes difference terms in the lagged dependent variable, the loan to income ratio, unwithdrawn equity and the debt service ratio. The model proved to fit the data well as indicated by an  $R^2$  of 0.9502 and the absence of



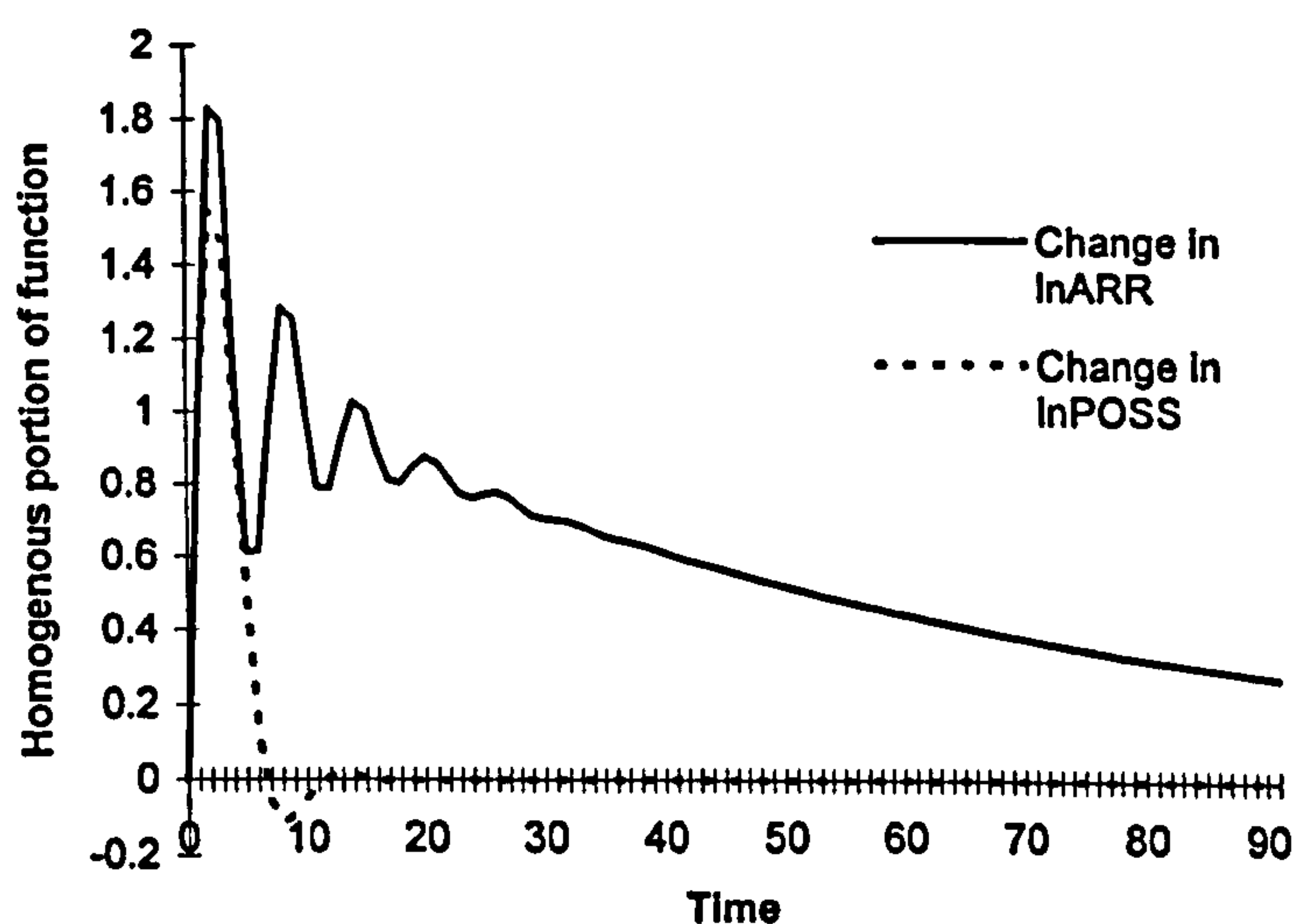
serial correlation in the residual series. In addition, Chow tests confirmed both the structural stability of the parameters of the model estimated between the two sample periods and also the accuracy of the predictions made (using the model estimated over the restricted sample) for the stock of arrears during the 1990s. The coefficient on the lagged residuals of the cointegrating relationship was found to be smaller than that of the house price equation, indicating that only 3 per cent of the adjustment of the arrears ratio to its long run equilibrium level occurred during each quarter.

The dynamic adjustment of the incidence of arrears was shown to be positively affected both by the debt service ratio and the term representing unwithdrawn equity, the latter against our *a priori* expectations. Additionally, the coefficient on the loan to income ratio appeared negatively in the equation, again not as expected. This is, nevertheless, consistent with the belief that in the short run mortgage lenders will only be willing to relax their lending policies on the basis of observed stability in aggregate mortgage repayments, whereas in the long run the greater the average mortgage loan relative to the income of the borrower will serve to increase the likelihood of default.

Again, the possessions equation passed both the structural stability test and also the predictive failure test with ease, although at the 5 per cent significance level serial correlation remained among the residuals of the model (however, the null hypothesis of no serial correlation could not be rejected at the 1 per cent level). An increase in the real rate of interest or the relative number of arrears or a reduction in the loan to value ratio were found to be associated with a rise in the flow into possession. The negative sign on the loan to value ratio implies that the adoption of more relaxed lending policies goes hand in hand with greater leniency towards those households facing possession. Indeed, it is also likely that we are observing a similar effect to that seen in the arrears equation, that in the short run lenders will only raise the loan to value ratio if they are not concerned over the flow into possession. The results reported here would suggest that the short run response of possessions to an exogenous shock is extremely slow; the coefficient on the residuals of the long run cointegrating regression is only just over 2 per cent, which compares to 9 per cent reported in B&J.

Finally, we must consider the autoregressive lag structure in both the arrears and possessions equations presented in Table 4.4 above. The general to specific methodology suggests that the current change in arrears and possessions depends on the first three autoregressive lags, and in both cases, the first and third lags are positive and the second negative. If we construct a series of the autoregressive components of the model alone (i.e. we are just considering the homogenous equation and ignoring the forcing process), when plotted against time both the autoregressive arrears and possessions series are found to be convergent and thus satisfy the stationarity restrictions for autoregressive models (see Figure 4.11 below).

**Figure 4.11 : The Homogenous Autoregressive Portion of the Dynamic Arrears and Possessions Equations<sup>43</sup>**



#### 4.4 SUMMARY AND CONCLUSIONS

This chapter has examined in depth the models of real house prices, arrears and possessions as proposed by Breedon and Joyce (1993). The introduction to the chapter examined the trends in nominal and real house prices, arrears and possessions in the UK housing market. The financial market deregulation of the 1980s (which

<sup>43</sup> The figure shows the path of  $\Delta \ln ARR$  and  $\Delta \ln POSS$  on the assumption that they are both of unit value in period 1 and zero before. In other words, we assume that  $\ln ARR$  and  $\ln POSS$  remain constant at their long run levels prior to period 1 at which point they undergo an exogenous one-off 1 per cent rise.



served to encourage competition in the mortgage market) led to borrowers taking on higher levels of mortgage debt relative to their income, making them particularly vulnerable to the general economic recession of the early 1990s. As the rate of unemployment rose (from 5.5 per cent in 1990Q2 to 10.5 per cent in 1993Q1) so too did the incidence of mortgage arrears. Moreover, with falling real and nominal house prices causing widespread negative equity, the higher rate of default inevitably led to a considerable increase in the number of households facing possession.

The theoretical model of real house prices is based on previous work by Dougherty and Van Order (1981), Poterba (1984), Ermisch (1984) and Meen (1990a) in which a household maximises utility by consuming housing services and a composite consumption good subject to a number of standard constraints. The real user cost of housing capital is derived from this optimisation problem and, following the specification of the demand for and supply of housing, an equation for the real house price is proposed.

The model for arrears is based on a paper by Brookes *et al* (1994) in which households fall into arrears if their mortgage repayments exceed the sum of disposable income plus the potential amount of equity which can be withdrawn from the housing asset. This 'arrears condition' is shown to depend on the mortgage lender's willingness to grant further loans on the basis of households' unwithdrawn equity. Finally, the decision to possess a house by the lender is assumed to depend upon the current price of the house and the lender's expectation of both the future house price and the borrower's ability to repay the loan.

Issues regarding the general specification of the data were addressed in Section 4.3.1, including the availability of the variables and the technique involved in seasonally adjusting the data (the cubic spline method of interpolating those series not available on a quarterly basis was addressed in Appendix 4.1). The two stage methodological framework of Engle and Granger (1987) was adopted for the estimation of all three models and specifically, the canonical cointegrating technique developed by Park (1992) was used to estimate the long run cointegrating relationships since it has been

shown that the parameter estimates are both efficient and most similar in size to the 'superconsistent' OLS results. However, for purposes of comparison, Appendix 4.3 presents the long run estimation results for a number of other estimation techniques : Phillips Hansen (1990) and Phillips (1993) fully modified procedures and also OLS.

Each long run equation was first estimated using the Johansen (1988) technique in order that the number of cointegrating relationships between the sets of variables could be determined; at least one cointegrating vector was found for *each* equation as required for cointegration. In addition, an examination of the residuals (and their autocorrelation functions) from the long run estimations confirmed their stationarity and therefore that the estimated models were indeed ones of cointegration.

The specifications of both the long run and short run equations were modified from those presented by B&J and were estimated over a longer period of time. The sample period for estimation was extended over that of B&J to include the tumultuous period in the housing market in the early 1990s during which time there was a continued decline in real and nominal house prices and a further increase, peak and subsequent decline in the flow of possessions and stock values of loans in arrear. This has had an important effect on altering the parameters of the long run regressions (Appendix 4.3 presents the long run cointegration results estimated over two sample periods, one including and one excluding the period post 1990/91). In particular, the failure of real personal incomes to fall significantly during the early 1990s' recession (compared to previous slowdowns) was the most likely cause of the poor performance of the income variable in both the long run house price and arrears equations.

Barring such anomalies, however, the results presented in this chapter for both the long run and short run equations are similar to those reported in B&J, a conclusion which one may assume ratifies not only the theoretical approach discussed in Section 4.2 but also the quarterly extended data set and indeed the method of estimation. The short run dynamic equations were shown to perform particularly well, the parameters being intertemporally stable and the models estimated over the restricted sample



period being able to forecast the dramatic changes in real house prices, arrears and possessions during the 1990s.

Future work on the theoretical framework could potentially link the three models of Section 4.2 more closely together, since as they stand they are rather diverse and *ad hoc*. However, perhaps the most important criticism of the model presented in this chapter is the fact that no explicit account is taken of the rental sector in either the theoretical or empirical modelling. Yet the markets for rental and owner occupied housing are inextricably linked. The long term decline in the UK rental market has, for example, been associated with a trend for increased owner occupation<sup>44</sup>. Government policy has been instrumental in influencing the balance between renting and owner occupation, such measures including rent controls, improved provision of public housing and the encouragement of owner occupation. Indeed, as a boom in the owner occupied market took root in 1985, the rate of decline in the rental sector housing stock, which had begun to stabilise during the 1970s and early 1980s, gathered momentum. By the end of the decade, the stock of private houses for rent accounted for under 10 per cent of the market. However, the decline was arrested following the passing of the 1988 Housing Act (which ended the system of rent controls by allowing landlords to set rents freely) and the ensuing slump in the owner occupier market.

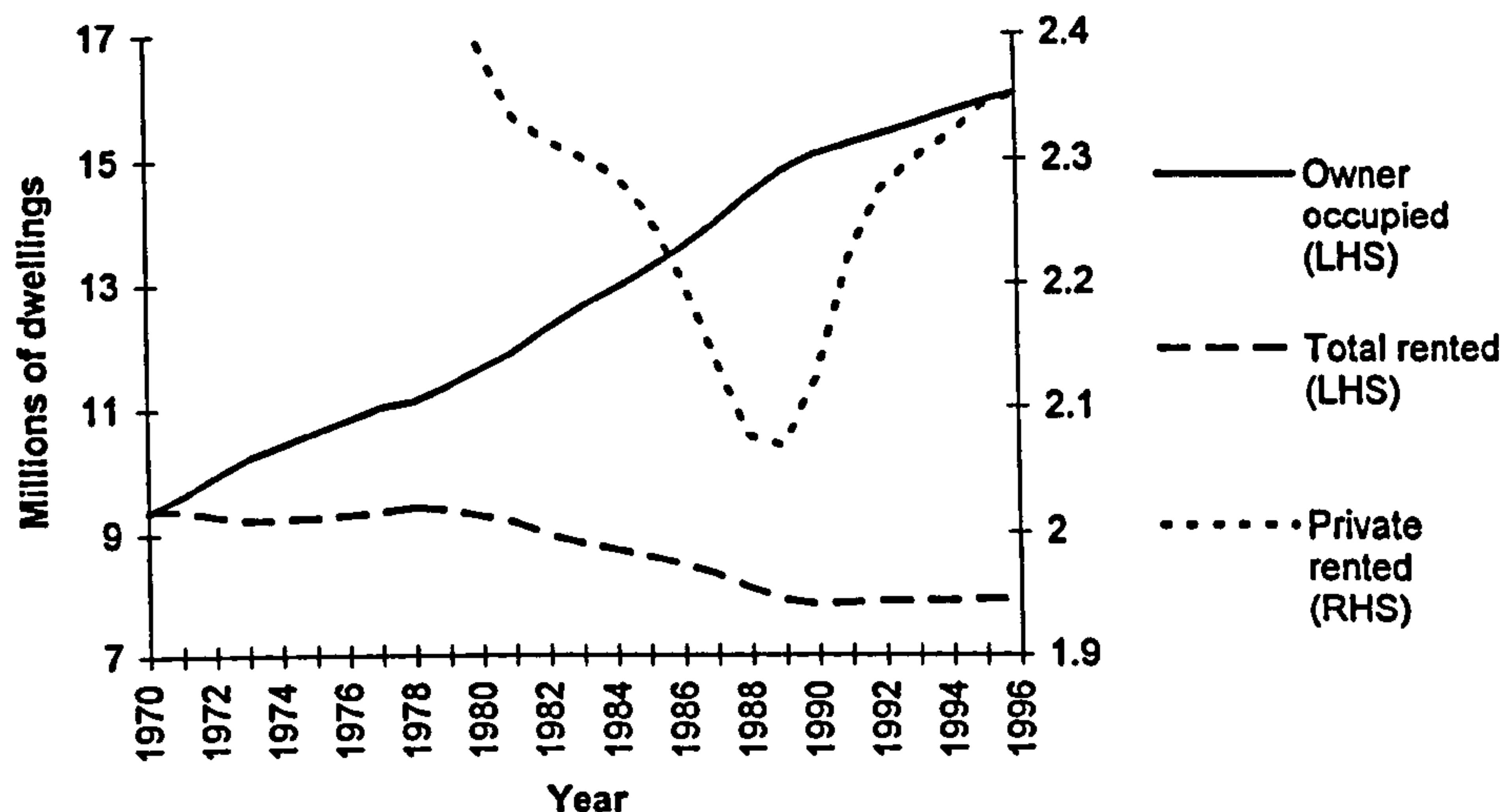
There is also more recent evidence to suggest the importance of the links between the owner occupied and rental housing markets. The current boom in the price of owner occupied housing has been influenced to a large extent by the fall in interest rates, which has encouraged not only owner occupation but also the purchase of houses to let. In the past, rising house prices have in general tended to imply rising rents as fewer houses are made available for rental purposes and landlords look to maintain a constant rental yield. This effect, however, may be more muted in the current environment given the popularity of buying to rent, which has had the effect of raising the supply of rental housing and thereby stemming any rise in rental charges. Indeed,

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<sup>44</sup> In fact the stock of private rentable accommodation has fallen from around 90 per cent of the total dwelling stock in 1900 to 50 per cent at the end of the second world war, 20 per cent in 1971 and only 11 per cent in 1981 (sources: Down, Holmans and Small (1994) and Abisogun (1992)).

the effect of over-supply in the rental market is confirmed in a recent study by property research group FPD Savills who report that apartment rents in London have fallen by around 4.3 per cent between mid-1998 and mid-1999.

**Figure 4.12 : The Decline in the Rental Market versus the Rise in Owner Occupation**



With regard mortgage default, a rise in possessions will also have implications for the rental sector since this should, according to the results presented earlier in the chapter, have a negative impact on house prices and possibly a positive effect on rents (a result of increased rental demand). Mortgage lending policies will additionally impact upon the rental sector to the extent that more stringent terms will deter potential owner occupiers.

Thus, the extent of the interdependence between the rental sector and the market for owner occupied housing would suggest that the natural path for future research would be the integration of the rental sector into a model of house prices and mortgage default. We could clearly expect, however, the dynamics and simultaneities of such a problem to be complex.



## CHAPTER 5

### A Theoretical Model of Building Society Interest Rate Setting

#### 5.1 INTRODUCTION

In this chapter, a theoretical model of building society interest rate setting is developed in order that the determinants of mortgage supply may be more rigorously identified prior to the formulation of an empirical model later in the thesis. In constructing the model it is argued that building societies will choose their rates of interest on mortgages and shares/deposits which in turn will determine the society's desired supply of each. In other words, the model is one of price rather than quantity setting.

The model presented here is developed from a paper by Smith *et al* (1981). Their work focuses on the modelling of US 'credit unions'<sup>1</sup> (hereafter referred to as 'CUs') by assuming that each institution maximises a weighted function of its members' welfare and profits subject to the constraint that profits be non-negative. The weighting parameters then determine the precise form taken by the optimal equations for both the mortgage rate and the savings rate of interest.

The model of Smith *et al* (1981) is adapted for UK building societies, and it is shown that by restricting the scope of the weighting parameters, the resulting optimal mortgage and savings rates chosen by the building society will not, up to a certain point, be a function of the weighting factors. Given that the weights chosen by the building society reflect the degree to which the society is oriented towards the maximisation of profit at one extreme or the allocation of financial benefits to its members at the other, the optimisation of the restricted objective function in the model presented in this chapter generates an important conclusion : that a building society with a higher regard for members' benefits than profitability (as given by the relative

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<sup>1</sup> Credit unions are financial intermediation co-operatives in which the demand for and supply of loanable funds is made up solely by its members. They are similar in nature to UK building societies and are described in more depth in Section 5.2.1 below.

weights of the objective function) will not, in general, set its interest rates differently to a building society assigning equal importance to the two objectives<sup>2</sup>. With the recent trend in the building society movement of institutions opting to relinquish their mutual status and become profit maximising banking firms<sup>3</sup>, this conclusion obviously has important implications for the interest rate setting policy of mutual financial institutions embarking on the conversion route.

Section 5.2 begins with a qualitative discussion of the similarities between credit unions and building societies and evaluates how the principles governing the way in which financial co-operatives have been modelled in the past may be applicable to the specification of an objective function for building societies. The preferred specification is then briefly discussed where it is shown that the objective function is simply a restricted form of that proposed by Smith *et al* (1981). Subsection 5.2.4 then applies the methodology of Patin and McNiel (1991) and Smith (1986) to UK building societies in order to provide an empirical justification for the restrictions placed on the theoretical model. The empirical proof is essentially a demonstration that UK building societies are in fact neutral in conferring financial benefits upon their borrowing and saving members through their policy of setting mortgage and share/deposit rates of interest. In Section 5.3 the optimisation of the model is presented and finally Section 5.4 concludes the chapter by summarising the findings of the model and discussing its implications.

## 5.2 THE SPECIFICATION OF AN OBJECTIVE FUNCTION FOR BUILDING SOCIETIES

Due to the unique institutional status of UK building societies and US credit unions, traditional models of financial intermediaries and co-operative enterprises cannot be applied directly to model their behaviour; profit maximising models may simply not be appropriate. This section endeavours to draw inferences as to the nature of the objective function of UK building societies by firstly analysing the way in which co-

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<sup>2</sup> As we will see later, however, there is an important restriction on the applicability of the model.

<sup>3</sup> See Chapter 2 for a discussion of the causes of and recent developments in the conversion of building societies to Plc status.



operative financial institutions have in the past been modelled and secondly by investigating empirically the extent to which any individual building society and the industry as a whole allocates a greater level of net monetary benefits to either its savers or borrowers.

### **5.2.1 The Nature of Credit Unions and Building Societies**

In this subsection the essential characteristics of the credit union movement in the US and the institutional similarities to the UK building society industry are considered. A brief discussion of the way in which the objective function of a typical building society or credit union may differ from that of a profit maximising private enterprise then follows.

A credit union is a financial intermediation co-operative in which the members are both the consumers of its output and suppliers of its input. The membership provides both the demand for and supply of loanable funds, the CU then intermediating between the borrower and saver members<sup>4</sup>. Because the credit union is a co-operative that deals exclusively with its members (without the need to interact with non-members), it has been referred to as the 'purest' type of co-operative (see Taylor (1971)). In this respect (and this is perhaps most important from a modelling perspective), the CU movement in the US is not unlike that of UK building societies, although it must not be overlooked that building societies do interact with non-members for purposes of financial intermediation<sup>5</sup>. In addition, US CUs are generally operated by their membership on a volunteer basis without pay.

However, an important difference is that unlike building societies, the membership of a CU is limited by what is referred to as a 'common bond'. Generally, these institutions cannot conduct business with the general public due to charter limitations restricting the CU to serving a membership characterised by a common bond, which

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<sup>4</sup> In co-operative theory terminology, the credit union is considered a 'purchasing' co-operative by its borrowers, and a 'marketing' co-operative by its saving members.

<sup>5</sup> On the liability side, for example, building societies are permitted to borrow in the wholesale interbank money markets up to a limit of 50 per cent of their total liabilities.

can be based on geographical area of residence, membership of a certain association or (more usually) common occupation<sup>6</sup>. It is noted by Smith (1984) that CUs may have “once-a-member-always-a-member” clauses and allow family member participation, going some way to expanding the upper bound to potential CU output. The common bond restriction is a feature mainly of US CUs, with some other countries having open (or community based) membership policies<sup>7</sup>. For the purpose of constructing an economic model of building society behaviour, it is therefore informative to think of a building society as a CU with either liberal or non-existent membership restrictions.

Taylor (1971) describes a CU in terms of its ‘subsidiary’ nature, which involves the CU, “having no profit motive of itself, but existing only to attain the economic and social goals of the people who comprise its membership”. Then it is alleged the economic behaviour of the CU is just an extension of the economic behaviour of its membership, not representing any independent behaviour or goals of its own<sup>8</sup>. This being the case, the CU must function in a way that is most advantageous to its members. The pecuniary benefits of CU membership are essentially the access to lower cost credit than that charged by alternative lending institutions and dividend rates on savings in excess of those offered by other depository institutions.

In this respect, recent legislative developments within the UK finance sector that have served to deregulate the building society industry must be taken into account in specifying a building society objective function since this represents a significant erosion of the subsidiary or non-profit nature of societies. It is alleged that no longer are societies entirely focused on the maximisation of member benefits as they were prior to the 1980s, but rather an increasing number are attaching weight to their corporate profits in addition to net member benefits in their objective function. In the extreme, a significant number of building societies have cast aside their mutual status

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<sup>6</sup> The purpose of the common bond restriction is allegedly to reduce the cost of gathering credit information and reducing losses from bad debts.

<sup>7</sup> It is important to point out that although credit unions may be found in many countries (including the UK), the US and Canada account for by far the largest share of CU activity.

<sup>8</sup> In later work, Taylor (1979) refers to this as, “the theory of non-independence”.



to become Plcs, a corporate structure in which it is commonly assumed that unqualified profit maximisation be the objective.

The objective function of a building society may then be assumed to contain elements of both member benefits and institutional profit, whereas the objective of a CU is to simply maximise its members benefits alone. Obviously, both CUs and building societies cannot maximise the deposit rate for savers whilst simultaneously minimising the loan rate charged to borrowers. Maintaining low loan rates may place a limit on the ability of the institution to pay dividends, while the maintenance of high dividend rates may necessitate higher lending rates. This heterogeneity of borrower and saver objectives gives rise to an inherent source of conflict between the net savers and net borrowers which make up the society's or CU's membership. In this respect, some credit unions are referred to as either borrower or saver dominated while others are considered neutral. This terminology relates to the partiality of the credit union (or building society) towards either borrowers or savers in choosing the relevant loan and saving rates (and thus the allocation of net benefits). This issue is addressed in more depth in the following Subsection 5.2.2.

### **5.2.2 The Borrower-Saver Conflict and Tests for Variant Objective Functions**

As we said above, it is considered reasonable in the economic analysis of the firm to make the assumption of unanimity among shareholders with respect to the firm's objective function, usually the maximisation of profit<sup>9</sup>. However, this concept of homogeneity is not applicable to a credit union or building society. Since the membership of a financial co-operative institution may be divided into net borrowers and net savers, a conflict between the two groups exists as to the institution's objective. Savers would prefer the objective of high deposit rates to be pursued whereas borrowers favour an objective of low lending rates. As noted in Smith *et al* (1981), "One cannot simply assume that the members seek to maximise the profit generated by their transactions with the CU irrespective of the price and quantity of those transactions".

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<sup>9</sup> Other objectives include the maximisation of the firm's market value or the rate of return on shareholders' equity.

This would imply that the general specification of the representative building society's objective function may be written as

$$Q = \phi NGL + \sigma NGS + \delta \pi \quad (5.1)$$

where  $NGL$  is the net gain to borrowing members from transacting with the society,  $NGS$  is the equivalent net gain to savers<sup>10</sup>,  $\pi$  is the society's profit and  $\phi$ ,  $\sigma$  and  $\delta$  are the weights attached to the components of the optimand (with  $\phi$  and  $\sigma$  reflecting the relative allocation of financial benefits between borrowers and savers of the CU respectively). The recent movement by UK building societies from a position of member benefit maximisation to one of profit maximisation would suggest a fall in the parameters  $\phi$  and  $\sigma$  over time and an upward trend in  $\delta$ . If member borrowers and savers are treated equally by the society with respect to their net gains, then one would expect to find  $\phi = \sigma$ .

Taylor (1971) was perhaps the first to explicitly recognise the potential inherent borrower-saver conflict in credit unions. Since the publication of his paper, the majority of subsequent work (both theoretical and empirical) in the area has acknowledged that the conflict between the member groups in the CU may affect the way in which CUs are operated. Such papers include Flannery (1974), Walker and Chandler (1977), Smith *et al* (1981) and Smith (1984). It is argued that it is the borrower-saver conflict and its resolution that could lead to the existence of a variety of credit union types, ranging from complete borrower or saver preference in the extreme to an intermediate position of neutrality.

Papers by Flannery (1974), Smith (1986) and Patin and McNiel (1991) address this issue directly by formulating tests to ascertain whether any particular credit union (and the industry as a whole) is 'borrower-dominated', 'saver-dominated' or 'neutral'. The latter two papers (which are discussed more fully below) both present evidence to suggest that the variant objective function hypothesis (i.e. that the financial benefits of one member group dominate those of the other) is *not* empirically supported for CUs.

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<sup>10</sup> The exact specification of net gains to borrowers and savers will be discussed in Section 5.2.3.



This is not particularly surprising for a number of reasons. Firstly, a neutral CU, according to Smith (1986), “typifies the altruistic motivations that lie at the heart of the co-operative philosophy”. Secondly, borrowers and savers are not always mutually exclusive groups, a fact which serves to lessen the inherent conflicting attitudes. To clarify this point, the classification of an agent as a net borrower or net saver depends crucially upon the stage of the individual’s life cycle. As a result of mortgage borrowing during the early and middle stages of the life cycle, an individual in this age group is more likely to be a net borrower than a net saver, whereas during the latter period in the life cycle (i.e. retirement), the agent is more likely to be a net saver. Thirdly, a CU must attain some balance between savings deposits and loans; the possibility of mass withdrawal (or even non-entry) by the non-preferred group should lead to neutrality as the only feasible objective. The importance of the result of neutrality is that one may subsequently focus on a simpler objective function in the modelling of CUs or building societies.

### 5.2.3 The Nature of the Restrictions to the Model of Interest Rate Setting

Smith *et al* (1981) propose a theory of CU interest rate setting whereby the level of lending and saving rates are chosen to maximise a weighted objective function of the welfare of the CU’s members (referred to below as net gains on loans,  $NGL$ , and net gains on savings,  $NGS$ ) and the profit of the institution. Simple linear specifications of loan demand and savings supply are assumed, the quantity of each depending on the spread between the CU’s rates of interest and those of the rest of the market. The complete optimisation problem may be written as

$$\text{Max}_{r_L, r_S} Q = \delta NGL + \sigma NGS + \pi \quad (5.2)$$

subject to the following constraint that profits be non-negative

$$\pi = r_L L - r_S S - r_{DM} D - C_L L - C_S S - \bar{E} \geq 0 \quad (5.3)$$

where  $r_L$  and  $r_S$  are the CU's rates of interest on loans and savings respectively, the net gains to borrowers and savers ( $NGL$  and  $NGS$ ) are assumed dependent on the relationship between the interest rates  $r_L$  and  $r_S$  and their market equivalents,  $L$  and  $S$  are the quantity of loans demanded from and savings supplied to the CU (again dependent on  $r_L$  and  $r_S$  and their respective market alternatives),  $D = L - S$  represents a debt issue by the CU if  $L > S$  and a wholesale money market investment if  $S > L$  (both of which attract a rate of interest  $r_{DM}$ ),  $C_L$  and  $C_S$  are constant average processing costs of loans and savings accounts respectively and  $\bar{E}$  represents fixed CU expenditures. Clearly, the specification of the objective function is the same as equation (5.1) above with  $\delta = 1$ .

The model of CU interest rate setting as discussed above is modified for application to UK building societies by placing an equality restriction on the weights of  $NGL$  and  $NGS$  ( $\delta$  and  $\sigma$  respectively) and adding a weight on the profit component in the objective function of equation (5.2). This amounts to the maximisation of the following function

$$\text{Max}_{r_L, r_S} \lambda(NGL + NGS) + (1 - \lambda)\pi \quad (5.4)$$

where  $0 \leq \lambda \leq 1$ . Again, the optimisation of this objective function is subject to the non-negative profit constraint of equation (5.3).

The fact that this model is more restrictive than that of equation (5.2) is not immediately apparent, since although a single weight is now applied to both  $NGL$  and  $NGS$ , an additional weight has been placed on the profit element in the maximand. However, by dividing through by  $(1 - \lambda)$  as we do in equation (5.5) below, it may be more clearly seen how the specification of (5.4) is more restrictive

$$\text{Max}_{r_L, r_S} \theta(NGL + NGS) + \pi \quad (5.5)$$



where  $\theta = \lambda / (1 - \lambda)$ , which is clearly more restrictive than the formulation of equation (5.1). Since  $\lambda$  must lie in the range between 0 and 1, the parameter  $\theta$  will lie in the range 0 and  $\infty$ .

The addition of a weight on the profit component equal to one less the weight on member benefits allows us to interpret  $\lambda$  as the degree to which building societies are committed to maximising member benefits rather than society profits (additions to reserves). Thus by observing the effects of the variation in  $\lambda$  on the optimal interest rate setting strategy of the building society we may infer how the mortgage and savings rates of interest may change once the society converts from being a mutual institution to a public limited company.

The primary reason for applying an equality constraint to the weights on *NGL* and *NGS* is that for a building society to achieve balance between its inflows and outflows of retail funds one may assume that it must be evenly handed in setting its mortgage and saving rates of interest<sup>11</sup>. However, with increased access to wholesale deposit markets building societies can potentially correct for any such retail imbalances through the inter-bank lending markets. Thus in Section 5.2.4 which follows, the notion that financial benefits are allocated evenly between the borrowing and saving members of UK building societies is empirically investigated (the findings being compared with those for credit unions using similar tests) allowing us to justify the specification of the objective function of equation (5.4) above.

#### **5.2.4 Empirical Tests for Variant Building Society Objective Functions**

Prior to the evaluation and testing of the hypotheses for variant objective functions among building societies, it is useful to consider a description of dominated and neutral building society behaviour. A very broad definition in Patin and McNiel (1991) describes dominated behaviour as occurring when, "one of the two groups [net borrowers or net savers] is benefited at the expense of another", and neutrality as when, "the CU [or building society in this case] is managed so that both member

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<sup>11</sup> Other explanations in addition to this are given in Section 5.2.2.

groups are equally benefited". The exact specification of these benefits is rather *ad hoc* and is discussed further later on.

The data set upon which the following estimations and analyses are performed is cross sectional data on all building societies with a level of total assets of £100m or more. This data was kindly supplied by Thesys Information Ltd. for the year 1995, during which the number of societies satisfying the minimum total asset requirement was 58.

#### 5.2.4.1 Smith's (1986) Methodology

Smith (1986) employs a procedure similar to that of Flannery (1974). Following Smith, building societies are firstly arbitrarily classified into borrower preference, saver preference or neutrality groupings based on the finding by Smith (1984) that as a building society tends towards saver (borrower) preference, both the interest rate on loans and the dividend rate on savings will increase (decrease). A potential classification criteria is then to categorise building societies as saver (borrower) oriented if both their loan and dividend rates are above (below) their respective industry sample means for any particular year.

However, a number of institutional factors will also affect the building society's mortgage and deposit rates, with the loan rate being additionally influenced by the composition of the society's lending portfolio (i.e. the type of loan and the risk associated with the borrower). Thus, in recognition of the effect of such factors, the mortgage and dividend rates are regressed against a number of proxy variables, the amended classification scheme then comparing the actual and predicted rate values. If the observed values for both the mortgage and dividend rates are greater than (less than) their predicted values, then the building society is deemed saver (borrower) preference, otherwise the society is considered to be neutral<sup>12</sup>. From this information we may construct two dummy variables for use later :  $BP = 1$  if the society is borrower preference,  $SP = 1$  if it is saver preference and  $BP = SP = 0$  otherwise.

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<sup>12</sup> The method is therefore simply an analysis of the residuals of the estimated equations. Positive residuals are indicative of saver preference while negative residuals would suggest borrower domination.



The results of the classification equations are shown in Table 5.1 below. Variables measuring building society total assets (*TA*) and the liquidity ratio (*LR*) are included in both interest rate regression equations; additional variables included in the mortgage rate equation are average mortgage size (*AVM*), the percentage of debt in arrear (*ARR*), the value of new mortgage advances over the year as a percentage of total advances as a proxy for mortgage turnover (*MT*) and losses written off as a percentage of average advances (*LOSS*).

**Table 5.1 : OLS Estimation of the Classification Equations**

Independent Variables	Dependent Variable : <i>Average Mortgage Rate</i>	Dependent Variable : <i>Average Dividend Rate</i>
Constant	7.2787 (17.28)	5.5111 (20.51)
<i>TA</i>	-2.07888E-09 (-0.62)	-1.572E-09 (-0.59)
<i>LR</i>	0.0371 (2.19)	0.0077 (0.01)
<i>AVM</i>	-0.0039 (-0.57)	
<i>ARR</i>	0.0077 (2.03)	
<i>MT</i>	9.67201E-05 (0.01)	
<i>LOSS</i>	-0.0272 (-0.12)	
<i>R</i> <sup>2</sup>	0.1915	0.0153

*t*-statistics in parentheses

Low  $R^2$  values for the classification equations indicate that the institutional variables have little explanatory power<sup>13</sup>. An analysis of the residuals led to 29.3 per cent or 17 of the 58 building societies being classified as borrower preference and the same percentage as saver preference according to the classification method described above. The remaining 24 societies (41.4 per cent) were unclassified.

The empirical test of the variant objective function hypothesis is then formed on the basis of a further result in Smith (1984) that in a saver (borrower) preference society, the dividend (loan) rate will tend to absorb any exogenous shocks while the loan

<sup>13</sup> Obviously, in the absence of any explanatory power of these regressions, the classification scheme reduces to a simple comparison of actual rates to sample means.

(dividend) rate tends to remain unchanged. The intuition behind this result is as follows. As borrower dominated building societies will tend to minimise the loan rate, savers' financial benefits will be excluded from the objective function; with the supply of deposits being taken as given, the dividend rate will then be optimally set to minimise the cost of funds. Exogenous shocks not affecting the deposit supply function (such as an exogenous fall in income or rise in costs) will thus not alter the savings rate, the loan rate alone reacting to the shock.

Similarly, in a saver preference society, the borrowers' demand schedule is assumed given, the loan rate being set to maximise the return on mortgage lending. The dividend rate then absorbs any exogenous shocks. The objective function of a neutral society would include both gains to borrowers *and* savers, with both interest rates reacting to any exogenous disturbances (borrowers and savers share in the positive and negative shocks).

The rates of interest on mortgage loans and savings are specified as reduced form equations dependent on a number of variables, the changes in which may be considered to be exogenous shocks. These are specified as the society's capital reserves ( $CR$ ), its average operating expenses ( $OP$ ) and its additions to reserves for the year ( $AR$ )<sup>14</sup> as follows

$$r_L = \alpha_0 + \alpha_1 CR + \alpha_2 OP + \alpha_3 AR \quad (5.6)$$

$$r_S = \alpha_4 + \alpha_5 CR + \alpha_6 OP + \alpha_7 AR \quad (5.7)$$

The variant objective function hypothesis suggests the signs of the coefficients to be  $\alpha_1 < 0, \alpha_2 > 0, \alpha_3 > 0$  and  $\alpha_5 = \alpha_6 = \alpha_7 = 0$  for borrower preference and  $\alpha_1 = \alpha_2 = \alpha_3 = 0$  and  $\alpha_5 > 0, \alpha_6 < 0, \alpha_7 < 0$  for saver preference. In other words, in a borrower (saver) preference society, higher capital reserves, lower expenses and

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<sup>14</sup> The use of additions to reserves in these equations, however, is debatable; since this profit measure is in part determined by the difference between  $r_L$  and  $r_S$ , the estimation may suffer from simultaneous equation bias.



lower additions to reserves allow the society to charge (offer) a lower (higher) rate on mortgages (savings) with the savings (mortgage) rate remaining unchanged.

The empirical test then is to determine whether the parameters of the classified groups differ significantly; if they do then the homogeneous objective function hypothesis must be rejected. This is where the original classification of borrower and saver preference comes in; assuming that all parameters of equations (5.6) and (5.7) differ according to equation (5.8)

$$\alpha_i = \gamma_{0i} + \gamma_{1i}BP + \gamma_{2i}SP \quad (5.8)$$

we may substitute equation (5.8) into equations (5.6) and (5.7) to give

$$\begin{aligned} r_L = & \gamma_{00} + \gamma_{10}BP + \gamma_{20}SP + \gamma_{01}(CR) + \gamma_{11}BP(CR) \\ & + \gamma_{21}SP(CR) + \gamma_{02}(OP) + \gamma_{12}BP(OP) + \gamma_{22}SP(OP) \\ & + \gamma_{03}(AR) + \gamma_{13}BP(AR) + \gamma_{23}SP(AR) \end{aligned} \quad (5.9)$$

and

$$\begin{aligned} r_S = & \gamma_{04} + \gamma_{14}BP + \gamma_{24}SP + \gamma_{05}(CR) + \gamma_{15}BP(CR) \\ & + \gamma_{25}SP(CR) + \gamma_{06}(OP) + \gamma_{16}BP(OP) + \gamma_{26}SP(OP) \\ & + \gamma_{07}(AR) + \gamma_{17}BP(AR) + \gamma_{27}SP(AR) \end{aligned} \quad (5.10)$$

Equations (5.9) and (5.10) are estimated by OLS, the results of which are presented in Table 5.2 below. Substantiation of the variant objective functions implies that  $\gamma_{1i} \neq \gamma_{2i}$ , a hypothesis that may be tested using the standard  $t$ -statistic for the equality of coefficients calculated as

$$t = \frac{\gamma_{1i} - \gamma_{2i}}{[\text{var}(\gamma_{1i}) + \text{var}(\gamma_{2i}) - 2\text{cov}(\gamma_{1i}, \gamma_{2i})]^{1/2}} \quad (5.11)$$

**Table 5.2 : OLS Estimation : Empirical Test for Variant Objective Functions**

Independent Variables	Dependent Variable : <i>Average Mortgage</i>	Dependent Variable : <i>Average Dividend</i>
	<i>Rate (<math>r_L</math>)</i>	<i>Rate (<math>r_S</math>)</i>
Intercept	7.0547 (15.47)	6.4936 (19.10)
<i>BP</i>	-0.6127 (-0.93)	-0.4520 (-0.92)
<i>SP</i>	1.4653 (2.07)	-0.5570 (-1.06)
<i>CR</i>	-1.2561 (-0.27)	1.4231 (0.40)
<i>BP(CR)</i>	-2.7152 (-0.52)	3.6277 (0.93)
<i>SP(CR)</i>	-0.5516 (-0.10)	-0.3191 (-0.07)
<i>OP</i>	50.7354 (2.37)	-37.3462 (-2.34)
<i>BP(OP)</i>	44.5656 (1.52)	21.9572 (1.00)
<i>SP(OP)</i>	-58.0159 (-2.25)	7.1026 (0.37)
<i>AR</i>	3.5788 (1.07)	-4.5242 (-1.82)
<i>BP(AR)</i>	4.8111 (0.97)	1.3528 (0.37)
<i>SP(AR)</i>	-9.9524 (-1.90)	2.9644 (0.76)
$R^2$	0.6037	0.6749

*t*-statistics in parentheses

The *t*-statistics are calculated for each set of coefficients in both equations, the sign of which is expected to be negative for *CR* and positive for both *OP* and *AR* based on the Smith's (1984) finding as discussed above. Six *t*-statistics are calculated (since there are two interest rate equations and three exogenous variables) the results of which are reported in Table 5.3 below.

**Table 5.3 : *t*-test Statistics for the Equality of Coefficients**

	<i>CR</i>	<i>OP</i>	<i>AR</i>
$r_L$	-0.54	4.15	2.71
$r_S$	1.32	0.81	-0.40

It can be seen from Table 5.3 above that *t*-test statistics for the  $r_L$  equation are all correctly signed, with the statistics on *OP* and *AR* being significant at the 5 per cent level. This can be taken to be supportive of the variant objective hypothesis.



However, results from the  $r_S$  equation are not at all supportive of the hypothesis, since two of the  $t$ -statistics are incorrectly signed and all are insignificant even at the 10 per cent level of significance. The results of the  $t$ -tests may thus be deemed inconclusive.

While the  $t$ -test results reported above are not particularly supportive of the existence of borrower and saver preference building societies, the hypothesis of neutrality between the interests of borrowers and savers is substantiated by observing that the estimated coefficients on the exogenous variables alone were all of the correct sign in *both* interest rate equations<sup>15</sup> despite being of varying significance (to reiterate, borrowers and savers in neutral building societies *both* share in the positive and negative shocks). The estimated coefficients on  $OP$  are the most significant, tending to be about 36 per cent higher (in absolute terms) in the mortgage rate equation than in the dividend equation. The coefficients on  $CR$  and  $AR$  in the dividend equation are 13 per cent and 26 per cent higher in absolute terms respectively than those of the mortgage rate equation. These results indicate that changes in profits and capital reserves will lead to a greater change in the interest rates to savers rather than borrowers while for a change in operating costs the reverse is true.

#### 5.2.4.2 Patin and McNiel's (1991) Methodology

Patin and McNiel (1991) form a more explicit empirical test of the variant objective function hypothesis than does Smith (1986). They assume that the identification of dominated behaviour will be reflected by the allocation of financial benefits between the net savers and net borrowers of the co-operative. These benefits, referred to as the net gains to the society's borrowers and savers, are specified as

$$NGL = (r_{LM} - r_L)L \quad (5.12)$$

and

$$NGS = (r_S - r_{SM})S \quad (5.13)$$

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<sup>15</sup> As expected, in the mortgage rate equation the coefficients on  $OP$  and  $AR$  were positive and that on  $CR$  was negative. The signs were reversed for the savings rate equation, again confirming the neutrality hypothesis.

where  $r_L$  and  $r_S$  are the rates on mortgages and savings offered by the society,  $r_{LM}$  and  $r_{SM}$  are the best alternative market mortgage and saving rates and  $L$  and  $S$  are the levels of mortgage loans and savings respectively<sup>16</sup>. For each building society, the difference between net monetary benefits is calculated simply as

$$d = NGS - NGL \quad (5.14)$$

where the building society allocates more net monetary benefits to its member savers (borrowers) if  $d$  is greater (less) than zero, and neutrality is implied by  $d = 0$ . The test is constructed for the industry as a whole by summing  $d$  over all building societies<sup>17</sup>.

In the calculation of the net gains to the borrowers and savers of building societies (equations (5.12) and (5.13)), the interest rate  $r_L$  is computed as the ratio of income received on mortgage advances during the year (1995 in this case) to the average level of total outstanding mortgage advances over the year, and the savings rate  $r_S$  is calculated as the ratio of the interest paid on retail funds during the year to average level of total outstanding retail funds over the year. In other words, these are *effective* weighted average interest rates on secured advances and retail funds. The alternative lending rate  $r_{LM}$  is calculated as the average mortgage lending rate of the main high street banks during 1995<sup>18</sup>, and the alternative savings rate  $r_{SM}$  is calculated for banks in a similar way to that of building societies<sup>19</sup>. Finally,  $L$  and  $S$  are the average levels of total outstanding mortgage loans and total outstanding retail shares and deposits over the year respectively.

Letting  $\bar{D}$  represent the mean of the differences between  $NGS$  and  $NGL$  for *all building societies in the population*, the test for the equitable allocation of benefits

<sup>16</sup> Both pairs of interest rates  $r_L$  and  $r_{LM}$ , and  $r_S$  and  $r_{SM}$  should be specified as weighted averages since several types of saving and loan instruments may be offered by building societies and their competitors. In addition, Patin and McNiel in their test of net financial distributions adjust the CU's loan rate for interest refunds. Since such practices are not commonplace within the UK building society industry, this correction is omitted in the empirical analysis reported here.

<sup>17</sup>  $\sum_{i=1}^n d_i > 0$ ,  $\sum_{i=1}^n d_i < 0$ ,  $\sum_{i=1}^n d_i = 0$  suggests that the industry as a whole is saver dominated, borrower dominated or neutral (respectively) where  $n$  is the total number of societies in the sample.

<sup>18</sup> The banks over which the average was taken are Abbey National, Bank of Scotland, Barclays, Lloyds, Midland, National Westminster, Royal Bank of Scotland and TSB.

<sup>19</sup> Due to data restrictions this effective alternative rate is taken to be that of the Midland Bank for 1995.



between the borrowing and saving members of building societies is based on a test of the null hypothesis of equality ( $H_0: \bar{D} = 0$ ) against the alternative hypothesis that there exists an inequitable distribution ( $H_1: \bar{D} \neq 0$ ). Acceptance of the null hypothesis would imply that the building society industry as a whole balances the financial interests of its savers and borrowers, whereas its rejection would indicate dominated behaviour (the sign and magnitude of  $\bar{D}$  indicating to which group the greater net benefit falls and the extent of the imbalance).

Since values of  $NGS$  and  $NGL$  are calculated for each building society in the sample, a 'matched pairs' situation is created in the process of computing  $d$  for each society. Applying the usual  $t$ -test for the differences in sample means is not appropriate because the assumption of independent samples can not be met. Thus, following Patin and McNiel (1991), the hypothesis is tested using the matched pairs  $t$ -test on the sample equivalent to  $\bar{D}$ , namely  $\bar{d}$ . This is a test procedure for analysing the difference between the means of two groups when the sample data are obtained from populations that are related. The matched pairs  $t$ -statistic is then<sup>20</sup>

$$t_{n-1} = \frac{\bar{d} - \mu_d}{S_D / \sqrt{n}} \quad (5.15)$$

where  $\mu_d$  is the hypothesised difference and  $S_D$  is the sample standard deviation of the difference. In this case, since  $\mu_d = 0$  the numerator simply becomes  $\bar{d}$ .

It was found that the mean value of  $d$  was £11.9m for 1995, with a matched-pairs  $t$ -statistic of 2.53, suggesting that  $\bar{D}$  is significantly different from zero at the 5 per cent level<sup>21</sup>. This rejection of  $H_0$  suggests a benefit imbalance towards savers. Taking the sample as a whole ( $\sum_{i=1}^n d_i$ ), building societies (with assets over £100m) allocated £688.7m more net monetary benefits to savers than borrowers in 1995<sup>22</sup>.

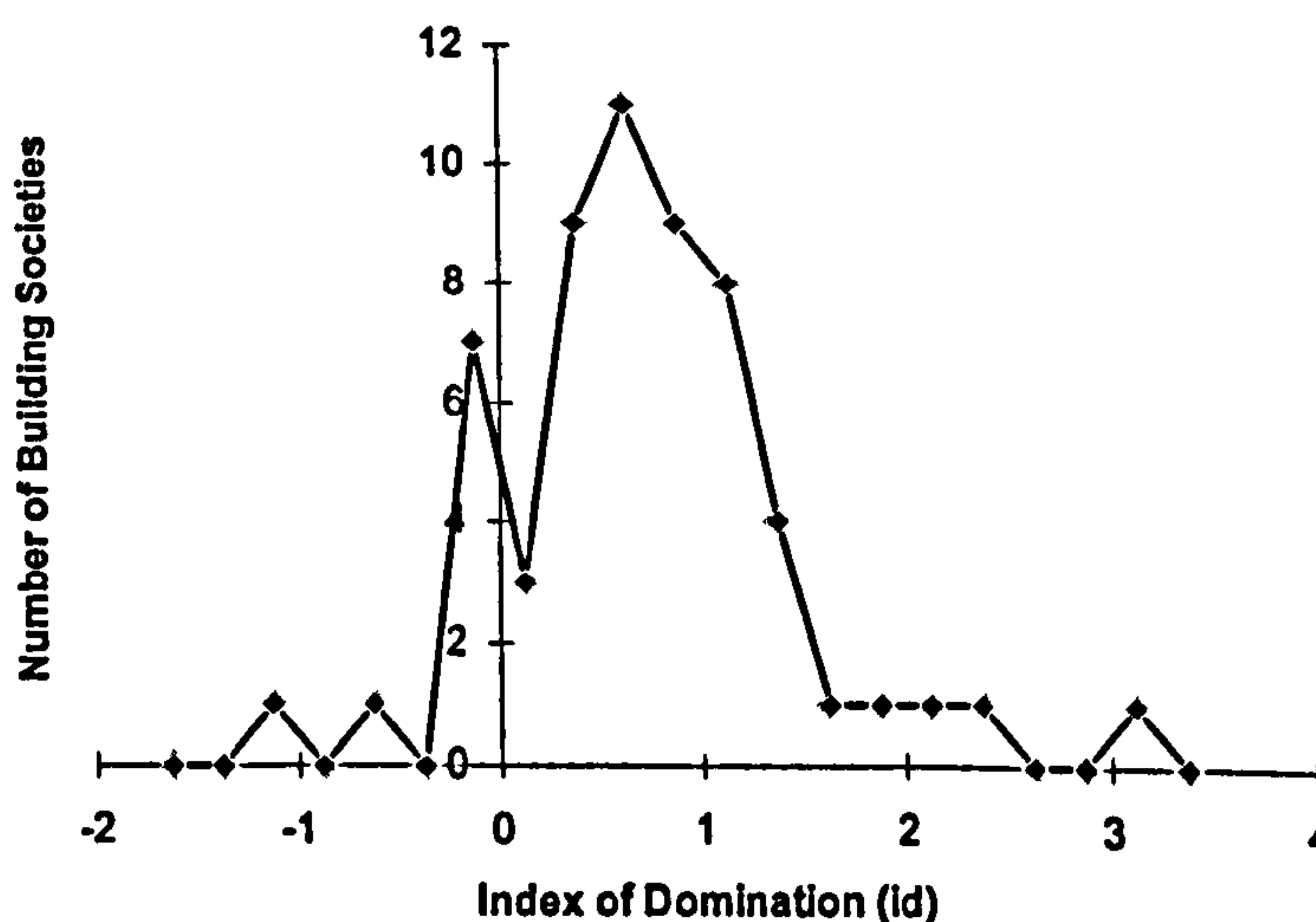
<sup>20</sup> See Berenson and Levine (1989) for a complete discussion of this method.

<sup>21</sup> The critical level of  $t$  with  $(n-1) = 57$  degrees of freedom is 2.00 at the 5 per cent level of significance for a two-tailed test.

<sup>22</sup> This is a comparatively small amount in relation to the total asset size of the building society sample. In fact the ratio of net saver benefits to total assets was only 0.22 per cent for 1995.

In addition to considering the industry as a whole, individual building societies' imbalances were examined. It was found that 15.5 per cent of building societies exhibited  $d < 0$  and 84.5 per cent had  $d > 0$  in 1995. However, since  $d$  is not standardised it can be misleading and subject to size bias when differently sized building societies are compared. Thus following Patin and McNiel an index of domination,  $id$ , is constructed for each building society as  $id = (ds - 0) / S_{D0}$ , where  $ds = (NGS / S) - (NGL / L)$  and  $S_{D0}$  is the standard deviation of  $ds$  about zero.  $ds$  is simply a standardised version of equation (5.14) and may be interpreted as the difference between  $NGS$  and  $NGL$  *per pound of savings or mortgage loans* (respectively). On standardisation,  $id$  indicates whether a building society is dominated towards its saver ( $id > 0$ ) or borrower ( $id < 0$ ) members. The distribution of  $id$  for all building societies is shown below in Figure 5.1

**Figure 5.1 : Frequency Distribution of the Index of Domination ( $id$ ) for all Building Societies with Assets of £100m and above (frequency intervals 0.25 wide)**



Building societies with values of  $id$  in the tails of the distribution exhibit strongly dominated behaviour whereas those with values grouped around zero can be seen as being relatively neutral. We may then classify building societies into four groups (saver or borrower dominated, neutral or unclassified) by comparing the values of  $id$  with some arbitrarily chosen critical values; obviously, the result of the classification is crucially dependent upon how liberally or restrictively such types of behaviour are



defined. Using very liberal criteria, it is found that of the classified building societies, 79 per cent showed evidence of neutral behaviour, the remaining 21 per cent being saver dominated. Such results are consistent with those of both Patin and McNiel (1991) and Smith (1986) for US credit unions.

**Table 5.4 : Classification of Building Societies into Dominated and Neutral Groups**

Classification	No. of Building Societies	
	<i>Liberal</i>	<i>Restrictive</i>
Borrower Preference	0	0
Neutral	19	2
Saver Preference	5	3
Unclassified	34	53
Total	58	58

Liberal critical values are defined to be  $-0.5 \leq id \leq 0.5$  for neutrality,  $id > 1.5$  for saver preference and  $id < -1.5$  for borrower preference. Restrictive critical values for  $id$  are  $-0.05 \leq id \leq 0.05$  for neutrality,  $id > 2.0$  for saver preference and  $id < -2.0$  for borrower preference.

Finally, we may address the question of whether the identified dominated building societies have distinctly different objective functions to the remainder of the population by comparing the expected characteristics of building societies with their actual behaviour.

Compared to a neutral society, we would expect that the interest rate paid to savers and the rate charged to mortgage borrowers will both be higher for saver dominated societies and lower for borrower dominated societies. This is indeed the case as indicated in Table 5.5 below, where it is assumed that building societies are saver dominated if  $id > 0$  and borrower dominated when  $id < 0$ . On average, saver dominated building societies set both their savings and mortgage rates just over 40 basis points higher than borrower dominated societies.

**Table 5.5 : Average Savings and Mortgage Rates for Saver (*SD*) and Borrower Dominated (*BD*) Building Societies, per cent**

	<i>SD</i> ( <i>di</i> > 0)	<i>BD</i> ( <i>di</i> < 0)
Average $r_s$	5.72	5.30
Average $r_L$	8.08	7.65

The results of the two methodologies presented above for the detection of building society partiality in allocating financial benefits to savers and borrowers are mixed. The methodology of Smith (1986) suggests that the neutrality hypothesis has greater validity than that of domination, whereas the Patin and McNiel (1991) approach implies that member group domination to some extent is an important feature of building society behaviour, with UK societies distributing a greater amount of net monetary benefit to savers than to borrowers in 1995. However, we must be cautious in drawing inferences from this latter conclusion since the number, asset size and member benefits of dominated societies in the sample was found to be relatively small in comparison to those that were classified as neutral; as we have already noted, the magnitude of the distribution of saver benefits in 1995 was minimal at only 0.22 per cent of total assets. In addition, the analysis was performed for the year 1995 alone yet it is likely that the distribution of benefits will have changed over time. On the basis of the conclusions discussed above, this thesis maintains the assumption of building society neutrality between borrowers and savers, which simplifies considerably the model of building society optimal interest rate setting set out in the following section.

### 5.3 A THEORY OF BUILDING SOCIETY INTEREST RATE SETTING

A theory of building society interest rate setting is developed as a straightforward Lagrange maximisation problem following Smith *et al* (1981). The building society is essentially viewed as a co-operative organisation which allows members to obtain higher returns on savings and pay lower rates on mortgages than they would through any other competing institution. Then the objective of the building society may be assumed to maximise a weighted function of a measure of borrowing and saving members' welfare (resulting from their transactions with the society) and the profit of



the building society by choosing the optimal interest rates on mortgages and savings. As before, these member benefits are denoted net gains on loans ( $NGL$ ) and net gains on savings ( $NGS$ ), and are specified in equations (5.12) and (5.13) in Section 5.2.4.2<sup>23</sup>.

Given the discussion of the most appropriate objective function in Section 5.2, we may restate the complete optimisation problem for the building society as to choose the rates of interest  $r_L$  and  $r_S$  in order to maximise the following objective function

$$\text{Max}_{r_L, r_S} \lambda(NGL + NGS) + (1 - \lambda)\pi \quad (5.16)$$

subject to the non-negative profit constraint

$$\pi = r_L L - r_S S - r_{DM} D - C_L L - C_S S - \bar{E} \geq 0 \quad (5.17)$$

where all notation is as defined previously in Section 5.2.3. It is interesting to note that since  $L$  and  $S$  are endogenous and appear in the objective function via the equations for  $NGL$  and  $NGS$ , the building society can be thought of as maximising a weighted function of profit and some function of membership activity.

To recapitulate, we noted briefly in Section 5.2.3 that the model differs from that of Smith *et al* by allowing weights to be attached not only to member benefits in the objective function but also to profit. In the model of Smith *et al* individual weights are attached to  $NGL$  and  $NGS$  whereas a unitary weight is applied to profit. In the objective function of equation (5.16) above, a single weight is applied to member benefits as a whole ( $0 \leq \lambda \leq 1$ ) and one minus this weight is applied to profits ( $1 - \lambda$ ).  $\lambda$  may thus be considered a behavioural motivation parameter, its value depending

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<sup>23</sup> In specifying  $r_{LM}$  and  $r_{SM}$  (the best alternative market mortgage and saving rates), there exists an aggregation problem since it is the case that not all members will face the same alternative market rates. This is true not only of the mortgage lending rate but also of the savings rate, both of which will depend upon the circumstances of the individual borrower. Smith *et al* (1981) cite charter limitations to credit union membership as possible mitigating factors; however, in the case of building societies, membership is more diverse. Here, the aggregation problem may be moderated on the lending side by the fact that the membership of societies is made up predominantly of first time buyers who most probably face similar alternative borrowing rates. Savings rates, on the other hand, vary explicitly with deposit size and as such are likely to suffer more from aggregation bias than lending rates.

upon the motivation of the building society towards maximising member benefits or profits. This may be of considerable importance in modelling the UK building society industry since over time one would expect the combined weight on *NGL* and *NGS* to be decreasing and the weight on profit to be increasing as societies have become more profit oriented and less focused on maximising member benefits.

Although the formulation set out above does not allow for a situation in which building societies attach greater importance to the benefits of either borrowers or savers in the objective function, it has been shown in Section 5.2.4 that there are justifications for ignoring this conflict.

### 5.3.1 The General Model

In the formulation of the model presented in this section, mortgage demand and savings supply schedules are specified in their most general form. In equations (5.18) and (5.19) below, both functions are assumed simply to be dependent upon the relevant building society rate of interest.

$$L = f(r_L), \quad f'(r_L) < 0 \quad (5.18)$$

and

$$S = g(r_S), \quad g'(r_S) > 0 \quad (5.19)$$

Substituting the mortgage demand and savings supply schedules of (5.18) and (5.19) into equations (5.12), (5.13) for member benefits and (5.17) for profit, recognising the balance sheet equality that  $D = L - S$  and substituting the member benefits and profit equations into the objective function of equation (5.16), we may rewrite the optimisation problem as

$$\begin{aligned} \text{Max}_{r_L, r_S} \quad & \lambda(r_{LM} - r_L)f(r_L) + \lambda(r_S - r_{SM})g(r_S) + (1 - \lambda)r_L f(r_L) \\ & - (1 - \lambda)r_S g(r_S) - (1 - \lambda)r_{DM} \{f(r_L) - g(r_S)\} \\ & - (1 - \lambda)C_L f(r_L) - (1 - \lambda)C_S g(r_S) - (1 - \lambda)\bar{E} \end{aligned} \quad (5.20)$$



subject to

$$\begin{aligned} \pi = & r_L f(r_L) - r_S g(r_S) - r_{DM} \{f(r_L) - g(r_S)\} \\ & - C_L f(r_L) - C_S g(r_S) - \bar{E} \geq 0 \end{aligned} \quad (5.21)$$

The Lagrangian may thus be formed as

$$\begin{aligned} \ell = & \lambda(r_{LM} - r_L)f(r_L) + \lambda(r_S - r_{SM})g(r_S) + (1-\lambda)r_L f(r_L) \\ & - (1-\lambda)r_S g(r_S) - (1-\lambda)r_{DM} \{f(r_L) - g(r_S)\} - (1-\lambda)C_L f(r_L) \\ & - (1-\lambda)C_S g(r_S) - (1-\lambda)\bar{E} - \gamma[r_L f(r_L) - r_S g(r_S) \\ & - r_{DM} \{f(r_L) - g(r_S)\} - C_L f(r_L) - C_S g(r_S) - \bar{E}] \end{aligned} \quad (5.22)$$

where  $\gamma$  is the Lagrange multiplier. Using the product rule of differentiation, the first order conditions for optimisation of the Lagrangian are then

$$\begin{aligned} \frac{\partial \ell}{\partial r_L} = & \lambda r_{LM} f'(r_L) - \lambda f(r_L) - \lambda r_L f'(r_L) + (1-\lambda)f(r_L) \\ & + (1-\lambda)r_L f'(r_L) - (1-\lambda)r_{DM} f'(r_L) - (1-\lambda)C_L f'(r_L) \\ & - \gamma f(r_L) - \gamma r_L f'(r_L) + \gamma r_{DM} f'(r_L) + \gamma C_L f'(r_L) \leq 0 \end{aligned} \quad (5.23)$$

and

$$\begin{aligned} \frac{\partial \ell}{\partial r_S} = & \lambda r_S g'(r_S) + \lambda g(r_S) - \lambda r_{SM} g'(r_S) - (1-\lambda)r_S g'(r_S) \\ & - (1-\lambda)g(r_S) + (1-\lambda)r_{DM} g'(r_S) - (1-\lambda)C_S g'(r_S) \\ & + \gamma r_S g'(r_S) + \gamma g(r_S) - \gamma r_{DM} g'(r_S) + \gamma C_S g'(r_S) \leq 0 \end{aligned} \quad (5.24)$$

and

$$\begin{aligned} \frac{\partial \ell}{\partial \gamma} = & r_L f(r_L) - r_S g(r_S) - r_{DM} \{f(r_L) - g(r_S)\} \\ & - C_L f(r_L) - C_S g(r_S) - \bar{E} \geq 0 \end{aligned} \quad (5.25)$$

Letting  $A = [f(r_L) + r_L f'(r_L)]$  and  $B = [r_{DM} f'(r_L) + C_L f'(r_L)]$  for the mortgage loan rate condition and  $C = [g(r_S) + r_S g'(r_S)]$  and  $D = [r_{DM} g'(r_S) - C_S g'(r_S)]$  for the savings rate condition, we may collect terms and simplify the notation in the above equations.

This allows us to write the Kuhn-Tucker conditions of this general problem as

$$\frac{\partial \mathcal{L}}{\partial r_L} = \lambda r_{LM} f'(r_L) + (1 - 2\lambda - \gamma)A + (\gamma - 1 + \lambda)B \leq 0, \quad r_L \geq 0 \quad (5.26)$$

and

$$\frac{\partial \mathcal{L}}{\partial r_S} = -\lambda r_{SM} g'(r_S) - (1 - 2\lambda - \gamma)C - (\gamma - 1 + \lambda)D \leq 0, \quad r_S \geq 0 \quad (5.27)$$

and

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \gamma} = & r_L f(r_L) - r_S g(r_S) - r_{DM} \{f(r_L) - g(r_S)\}, \quad \gamma \geq 0 \\ & - C_L f(r_L) - C_S g(r_S) - \bar{E} \geq 0 \end{aligned} \quad (5.28)$$

each with complementary slackness. With two non-negative variables and one inequality constraint, there are  $2^3 = 8$  possible patterns of equations and inequalities. However, if we assume that for a viable solution we require  $r_S$  and  $r_L$  to be strictly positive, this allows us to write the optimal conditions (5.26) and (5.27) as equalities<sup>24</sup>. It is not certain as to whether the non-negative profit constraint will bind as a strict equality or if it will be slack, and therefore the inequality sign is maintained on condition (5.28). This reduces the complexity of the problem considerably since there are now only two possible patterns of equations and inequalities. Therefore, in the analysis which follows, all first order conditions for the two interest rate variables will be presented as equality constraints.

#### 5.3.1.1 Solutions of the General Model for Specific Values of $\lambda$

In the general solution, the optimum interest rates chosen by the building society on both mortgage loans and savings deposits will be dependent upon the weights in the objective function. As such, solutions for three specific values of  $\lambda$  ( $\lambda = 0, 1, 0.5$ ) are derived below.

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<sup>24</sup> The trivial cases in which  $r_L$  and/or  $r_S$  are zero are of no interest and are thus ignored here.



- *Case 1 :  $\lambda = 0$ , Profit Maximisation*

In the case of profit maximisation, the building society ignores the value of transactions to its membership and the objective of the society becomes simply that of maximising profit. The conditions for optimality then turn out to be

$$\frac{\partial \mathcal{L}}{\partial r_L} = (1 - \gamma)[f(r_L) + r_L f'(r_L) - r_{DM} f'(r_L) - C_L f'(r_L)] = 0 \quad (5.29)$$

and

$$\frac{\partial \mathcal{L}}{\partial r_S} = (1 - \gamma)[r_{DM} g'(r_S) - g(r_S) - r_S g'(r_S) - C_S g'(r_S)] = 0 \quad (5.30)$$

Using the simplifying notation defined above, these conditions may be written as follows

$$\frac{\partial \mathcal{L}}{\partial r_L} = (1 - \gamma)[A - B] = 0 \quad \text{or} \quad A = B \quad (5.31)$$

and

$$\frac{\partial \mathcal{L}}{\partial r_S} = (1 - \gamma)[D - C] = 0 \quad \text{or} \quad C = D \quad (5.32)$$

Another way of writing these conditions is

$$\frac{d}{dr_L} r_L f(r_L) = \frac{d}{dr_L} f(r_L)(r_{DM} + C_L) \quad (5.33)$$

and

$$\frac{d}{dr_S} r_S g(r_S) = \frac{d}{dr_S} g(r_S)(r_{DM} - C_S) \quad (5.34)$$

Equation (5.33) says that the building society will choose to set its mortgage rate of interest at such a level whereby an infinitesimally small change in that rate will lead to a change in total receipts from retail mortgage lending equal to the change in total receipts from lending in the wholesale market instead (i.e. without resorting to a

change in retail savings). Similarly, equation (5.34) implies that a society will select its optimal savings rate such that any infinitesimally small change in that rate will lead to a change in the total interest cost of maintaining its retail savings deposits equal to the change in the total interest cost of using wholesale deposits instead. The cost of processing retail loans (savings) is shown to be added to (subtracted from) the money market rate  $r_{DM}$  reflecting the fact that the return on lending and the cost of deposits in the wholesale market are free of non-interest processing costs, unlike their retail counterparts.

- *Case 2 :  $\lambda = 1$ , Complete Member Orientation*

In contrast to Case 1, when  $\lambda = 1$  the building society is not interested in profit maximisation. Rather, it will maximise the benefits of its members (as defined in equations (5.12) and (5.13)) subject to the condition that it does not make negative profit. In general, member orientation may be defined as occurring whenever  $\lambda > 0.5$ , with the preference towards members rather than profit being described as *complete* when the ratio of the weight on member benefits to the weight on profits,  $\lambda / (1 - \lambda)$ , tends to infinity. The optimal conditions for this case may then be stated as

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial r_L} &= r_{LM} f'(r_L) - (1 + \gamma)[f(r_L) + r_L f'(r_L)] \\ &\quad + \gamma[r_{DM} f'(r_L) + C_L f'(r_L)] = 0 \end{aligned} \tag{5.35}$$

and

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial r_S} &= -r_{SM} g'(r_S) + (1 + \gamma)[g(r_S) + r_S g'(r_S)] \\ &\quad - \gamma[r_{DM} g'(r_S) - C_S g'(r_S)] = 0 \end{aligned} \tag{5.36}$$

Using the concise notation as above, we may rewrite equations (5.35) and (5.36) as

$$\frac{\partial \mathcal{L}}{\partial r_L} = r_{LM} f'(r_L) - (1 + \gamma)A + \gamma B = 0 \tag{5.37}$$



and

$$\frac{\partial \mathcal{L}}{\partial r_s} = -r_{SM}g'(r_s) + (1+\gamma)C - \gamma D = 0 \quad (5.38)$$

- *Case 3 :  $\lambda = 0.5$ , Equal Weighting on Member Benefits and Profit*

In this case, member benefits and profit command the same weight of 0.5 in the objective function. The conditions required to derive the optimal rates of interest may be written as

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial r_L} &= 0.5[r_{LM}f'(r_L)] - \gamma[f(r_L) + r_Lf'(r_L)] \\ &\quad + (\gamma - 0.5)[r_{DM}f'(r_L) + C_Lf'(r_L)] = 0 \end{aligned} \quad (5.39)$$

and

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial r_s} &= -0.5[r_{SM}g'(r_s)] + \gamma[g(r_s) + r_sg'(r_s)] \\ &\quad - (\gamma - 0.5)[r_{DM}g'(r_s) - C_sg'(r_s)] = 0 \end{aligned} \quad (5.40)$$

Again, using the more concise notation as defined above, these conditions may be simplified as follows

$$\frac{\partial \mathcal{L}}{\partial r_L} = \gamma[B - A] + \frac{[r_{LM}f'(r_L) - B]}{2} = 0 \quad (5.41)$$

and

$$\frac{\partial \mathcal{L}}{\partial r_s} = \gamma[C - D] - \frac{[r_{SM}g'(r_s) - D]}{2} = 0 \quad (5.42)$$

### 5.3.2 A Specific Problem

In order to derive more specific results to make inferences as to the optimal behaviour of building societies when setting their rates of interest, we must now assume explicit forms for the equations describing the demand for mortgage loans and the supply of

savings. Both functions are assumed to be linear and are specifically given by the following equations

$$L = f(r_L) = p + \alpha(r_{LM} - r_L), \quad \alpha > 0 \quad \text{with} \quad \frac{\partial L}{\partial r_{LM}} > 0, \frac{\partial L}{\partial r_L} < 0 \quad (5.43)$$

and

$$S = g(r_S) = q + \beta(r_S - r_{SM}), \quad \beta > 0 \quad \text{with} \quad \frac{\partial S}{\partial r_{SM}} < 0, \frac{\partial S}{\partial r_S} > 0 \quad (5.44)$$

where  $p$  and  $q$  are constant terms. Equation (5.43) simply says that the quantity of mortgage loans demanded is proportional to the spread between the best alternative mortgage loan rate in the market and the interest rate offered by the building society on mortgage loans. Equivalently, equation (5.44) implies that the quantity of savings supplied is a constant function of the difference between the savings rate offered by the society and the corresponding best alternative rate. The positive coefficients of  $\alpha$  and  $\beta$  reflect the fact that the offer of more attractive interest rates by a building society will encourage a greater level of member transactions with the society.

These specifications of loan demand and savings supply equations differ from those proposed by Smith *et al* in that they contain constant terms ( $p$  and  $q$  respectively), which does serve to complicate the algebra and the subsequent solution. There are good reasons for the introduction of constant terms in the mortgage loan and savings equations despite the complications. Firstly, by omitting a constant, the demand for mortgage loans and supply of savings depends only on the difference between the rates of interest offered by banks and building societies on mortgages and savings respectively. With parameters  $\alpha$  and  $\beta$  greater than zero, this implies that a higher (lower) rate of interest on building society mortgages (savings) than their competitors will lead to a negative stock demand for (supply of) loans (savings) which is obviously infeasible. Second, without a constant term, the loan demand and savings supply schedules are clearly improperly specified. The demand for building society mortgage loans, for example, depends upon more than just a comparison of the best alternative mortgage rate with the rate offered by the society; it will also be a function



of household income, expected lifetime wealth, the user cost of housing and other factors (see Section 6.2.2 of Chapter 6 for a formal model of the demand for mortgage finance). Since we may assume that the building society will treat these as constant in its optimisation process, the intercept terms included in this model will capture their effects.

The optimal conditions may then be found by substituting in the specific mortgage demand and savings supply schedules described by equations (5.43) and (5.44) and their derivatives for the general formulas as set out in Section 5.3.1. In the following two subsections, optimal interest rate setting equations are derived for a non-specific value of  $\lambda$  (i.e.  $0 \leq \lambda \leq 1$ ) and in addition the three alternative particular values of  $\lambda$ .

#### 5.3.2.1 Solutions of the Specific Model for General $\lambda$

When the value of  $\lambda$  is unspecified, the optimal rates are derived as

$$r_L^* = \frac{2\lambda r_{LM} + (\gamma + \lambda - 1)(r_{LM} + r_{DM} + C_L)}{2(2\lambda - 1 + \gamma)} + \frac{p}{2\alpha} \quad (5.45)$$

and

$$r_S^* = \frac{2\lambda r_{SM} + (\gamma + \lambda - 1)(r_{SM} + r_{DM} - C_S)}{2(2\lambda - 1 + \gamma)} - \frac{q}{2\beta} \quad (5.46)$$

When the non-negative profit constraint binds,  $\gamma$  may be shown (after considerable algebraic manipulations) to be derived from the following formula

$$\gamma = 1 - 2\lambda + \frac{\lambda}{\left[1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]}\right]^{1/2}} \quad (5.47)$$

where

$$Z = 4\bar{E} - \left[ \frac{p^2}{\alpha} + \frac{q^2}{\beta} + 2p(r_{LM} - r_{DM} - C_L) + 2q(r_{DM} - r_{SM} - C_S) \right] \quad (5.48)$$

With no constant terms (i.e.  $p = q = 0$ ) it will simply be the case that  $Z = 4\bar{E}$ . Since (5.47) has been solved on the assumption of an equality constraint, this solution is only valid for such cases when the profit constraint is binding. When the constraint does not bind, the optimal rates can be determined by substituting  $\gamma = 0$  into equations (5.45) and (5.46). Formally, the use of equation (5.47) in calculating  $\gamma$  will generally yield  $\gamma \neq 0$  forcing the profit constraint to bind. Substituting equation (5.47) for  $\gamma$  into the optimal rate equations of (5.45) and (5.46) yields

$$r_L^* = \frac{(r_{LM} + r_{DM} + C_L)}{2} + \frac{p}{2\alpha} + \frac{(r_{LM} - r_{DM} - C_L)}{2} \left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2} \quad (5.49)$$

and

$$r_S^* = \frac{(r_{DM} + r_{SM} - C_S)}{2} - \frac{q}{2\beta} - \frac{(r_{DM} - r_{SM} - C_S)}{2} \left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2} \quad (5.50)$$

Again, it is important to note that these optimal interest rate solutions will only be valid for cases in which the profit constraint is binding.

Turning to the importance of  $\bar{E}$  in the optimal interest rate solutions (5.49) and (5.50), if  $\bar{E} = 0$  and there are no constants in the loan demand or savings supply equations, then the optimal rate solutions will not be functions of the elasticity parameters  $\alpha$  and  $\beta$ . In fact, in such circumstances the building society will simply set its optimal mortgage and savings rates equal to the alternative market rates (i.e.  $r_{LM}$  and  $r_{SM}$  respectively)

Finally, we may turn to the issue of the debt issue decision of the building society. For any particular building society, debt will be issued whenever the level of loans is greater than the level of savings. In other words, there will be a debt issue when  $L - S > 0$ , or specifically when  $p + \alpha(r_{LM} - r_L) > q + \beta(r_S - r_{SM})$ . The debt issue



condition may be determined by inserting the optimal rates of equations (5.45) and (5.46) into the inequality  $L > S$ , giving

$$D \stackrel{\geq}{=} 0 \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S)}{\alpha + \beta} + \frac{(p - q)(1 - \gamma - 2\lambda)}{(\alpha + \beta)(1 - \gamma - \lambda)} \stackrel{\geq}{=} r_{DM} \quad (5.51)$$

If it is the case that the profit constraint is binding then we may substitute in for  $\gamma$  from equation (5.47) above, upon which the debt issue condition can be shown to be

$$D \stackrel{\geq}{=} 0 \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S)}{\alpha + \beta} + \frac{(p - q)}{(\alpha + \beta)} \frac{1}{1 - S} \stackrel{\geq}{=} r_{DM} \quad (5.52)$$

where

$$S = \left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2} \quad (5.53)$$

Thus when the profit constraint binds, the debt issue condition is shown not to be dependent upon  $\lambda$ .

### 5.3.2.2 Solutions of the Specific Model for Specific $\lambda$

- *Case 1 :  $\lambda = 0$ , Profit Maximisation*

We know that in the case of pure profit maximisation, the society will face a particularly simple optimisation problem : to maximise profits subject to profits being non-negative. In such conditions, we know that in all interesting cases the profit constraint cannot bind; if it did, this would imply that societies were attempting to maximise profits subject to the constraint that profits are zero, which must amount simply to maximising zero. Clearly, when  $\lambda = 0$  the only outcomes which are of interest are when the profit constraint does not bind, i.e. when profits are strictly positive. The formal proof that the profit constraint does not bind when  $\lambda = 0$  is a proof by contradiction. If the profit constraint binds then the equation for the Lagrange multiplier can be written as an equality in (5.47) above, which on

substituting in for  $\lambda = 0$  gives  $\gamma = 1$ . When both  $\lambda = 0$  and  $\gamma = 1$  are substituted into the optimal interest rate equations of (5.45) and (5.46) an inconsistency is observed : a ratio of two zeros appears in both equations, which are said to be undefined and discontinuous at  $\lambda = 0$  and  $\gamma = 1$ . This must imply that the profit constraint cannot be binding.

Given that the profit constraint will be slack, the complementary slackness conditions of the Kuhn-Tucker theorem allow us to conclude that the Lagrange multiplier must be zero. Thus for the specific loan demand and savings supply schedules of (5.43) and (5.44) above, the optimal lending and saving rates of interest when the building society maximises profit alone may therefore be derived by setting  $\lambda = 0$  and  $\gamma = 0$  in equations (5.45) and (5.46) to achieve<sup>25</sup>

$$r_L^* = \frac{r_{LM} + r_{DM} + C_L}{2} + \frac{p}{2\alpha} \quad (5.54)$$

and

$$r_S^* = \frac{r_{SM} + r_{DM} - C_S}{2} - \frac{q}{2\beta} \quad (5.55)$$

By considering the objective function of Smith *et al* (1981) in equation (5.2) of Section 5.2.3 it can be seen that their model will yield the same results as that outlined above only under circumstances in which  $\lambda = 0$  (i.e. profit maximisation) *and* there is no constant term in the model (i.e.  $p = q = 0$ ). In this case, the second terms in equations (5.54) and (5.55) drop out.

After substitution of equations (5.54) and (5.55) into equation (5.17) for profits, the maximum surplus may be shown to be

$$\pi^* = \frac{\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2 - Z}{4} > 0 \quad (5.56)$$

<sup>25</sup> These optimal interest rates may equivalently be derived by substituting in for  $f(r_L)$  and  $g(r_S)$  in equations (5.31) and (5.32) of the general solution and setting  $\gamma = 0$ .



where  $Z$  is defined in equation (5.48) of Section 5.3.2.1. When there exists no constant terms,  $Z = 4\bar{E}$  and the maximum surplus simplifies to

$$\pi^* = \frac{\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2}{4} - \bar{E} \quad (5.57)$$

Since we know that in this case  $\pi^* > 0$ , the expression for optimal profit above places a ceiling on  $\bar{E}$ , the expenditure on fixed costs.

As we noted before, debt will be issued when  $D = L - S > 0$  (or  $L > S$ ). Thus the debt issue condition for Case 1 may be formulated by substituting the optimal interest rate equations derived in (5.54) and (5.55) into the debt issue inequality,  $p + \alpha(r_{LM} - r_L) > q + \beta(r_S - r_{SM})$ , or alternatively by substituting  $\lambda = 0$  and  $\gamma = 0$  into equation (5.51), yielding

$$D \stackrel{\geq}{=} 0 \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S) + (p - q)}{\alpha + \beta} \stackrel{\geq}{=} r_{DM} \quad (5.58)$$

• *Case 2 :  $\lambda = 1$ , Complete Member Orientation*

When profit maximisation is ignored and member benefits alone appear in the building society's objective function, by substituting  $\lambda = 1$  into equations (5.45) and (5.46) (or alternatively substituting in for  $f(r_L)$  and  $g(r_S)$  in equations (5.37) and (5.38)) the optimal interest rates may be derived as

$$r_L^* = \frac{2r_{LM} + \gamma(r_{LM} + r_{DM} + C_L)}{2(1 + \gamma)} + \frac{p}{2\alpha} \quad (5.59)$$

and

$$r_S^* = \frac{2r_{SM} + \gamma(r_{SM} + r_{DM} - C_S)}{2(1 + \gamma)} - \frac{q}{2\beta} \quad (5.60)$$

These optimal rates may be written alternatively as

$$r_L^* = \delta \left[ \frac{r_{LM} + r_{DM} + C_L}{2} \right] + (1 - \delta)r_{LM} + \frac{p}{2\alpha} \quad (5.61)$$

or

$$r_S^* = \delta \left[ \frac{r_{SM} + r_{DM} - C_S}{2} \right] + (1 - \delta)r_{SM} - \frac{q}{2\beta} \quad (5.62)$$

where  $\delta = \gamma / (1 + \gamma)$ . From the complementary slackness conditions of the Kuhn-Tucker theorem we know that we must have  $\gamma \geq 0$  which implies that both weights  $\delta$  and  $(1 - \delta)$  are non-negative and range from 0 to 1, with  $\delta$  approaching 1 and  $(1 - \delta)$  approaching 0 as  $\gamma$  approaches infinity. In other words, the optimal interest rates on mortgage loans and savings are simply weighted averages of the respective profit maximising interest rates and the alternative rates of interest offered in the market.

It must be the case that when  $\lambda = 1$  and the building society is interested solely in the maximisation of member benefits that the non-negative profit constraint must bind, i.e. that profit must be zero ( $\pi = 0$ ) at the optimum interest rate combination. To see why, imagine that profits were positive at the rates of interest chosen by the building society. Then it must be true that the society can reduce the mortgage rate of interest and raise the savings rate to raise both the net gain on loans and the net gain on savings<sup>26</sup> at the expense of profits. Given that the society's behavioural objective is to maximise members' financial benefits, it will continue to do this until profits are driven down to zero; the initial interest rate combination could therefore not have been an optimum.

Given that we know the non-negative profit constraint is binding, the solution for  $\gamma$  in equation (5.47) will be valid. The solution for  $\gamma$  when  $\lambda = 1$  can be attained either by substituting both optimal interest rates of equations (5.59) and (5.60) into the budget

<sup>26</sup> Not only will the interest rate differentials be greater in the formulations for *NGL* and *NGS* of equations (5.12) and (5.13) but also with  $\alpha, \beta > 0$  in equations (5.43) and (5.44) the value of loans and savings transacted with the society must increase. Taken together, this implies an unequivocal increase in net member benefits.



constraint of equation (5.17), or by substituting  $\lambda = 1$  into the general solution for  $\gamma$  as given in equation (5.47) to obtain<sup>27</sup>

$$\gamma = \frac{1}{\left[1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]}\right]^{1/2}} - 1 \quad (5.63)$$

where  $Z$  is as defined previously.

The optimal rates of interest once we substitute in for  $\gamma$  in equations (5.59) and (5.60) are then as given in equations (5.49) and (5.50) for the general solution.

The debt issue condition may be formulated for Case 2 by substituting the optimal rate equations (5.59) and (5.60) into the debt issue inequality  $p + \alpha(r_{LM} - r_L) > q + \beta(r_S - r_{SM})$  or alternatively by inserting  $\lambda = 1$  into the general condition of (5.51) to give

$$D \begin{matrix} \geq \\ = 0 \\ \leq \end{matrix} \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S) + (p - q)(1 + \gamma) / \gamma}{\alpha + \beta} \begin{matrix} \geq \\ = \\ \leq \end{matrix} r_{DM} \quad (5.64)$$

Given that the profit constraint is binding, we may substitute in for  $\gamma$  (as defined in equation (5.47)) in equation (5.64), the optimal debt condition then becoming that shown in the general solution of equation (5.52).

- *Case 3 :  $\lambda=0.5$ , Equal Weighting on Member Benefits and Profit*

When member benefits and profit command the same weight in the objective function, the optimal rates of interest may be determined by either substituting equations (5.43) and (5.44) into the general solution of (5.41) and (5.42) or by substituting  $\lambda = 0.5$  into equations (5.45) and (5.46).

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<sup>27</sup> A full derivation of  $\gamma$  for Cases 2 and 3 are provided in Appendix 5.1.

This gives

$$r_L^* = \frac{r_{LM} + r_{DM} + C_L}{2} - \frac{r_{DM} - r_{LM} + C_L}{4\gamma} + \frac{p}{2\alpha} \quad (5.65)$$

and

$$r_S^* = \frac{r_{SM} + r_{DM} - C_S}{2} + \frac{r_{SM} - r_{DM} + C_S}{4\gamma} - \frac{q}{2\beta} \quad (5.66)$$

When there exists no constant term,  $p = q = 0$  and the final terms of equations (5.65) and (5.66) drop out. Clearly it must be the case that  $\gamma \neq 0$ ; if it were the case that  $\gamma = 0$ , the solution above for the mortgage interest rate would be *infinitely* negative and that for the savings rate infinitely large. This implies that the constraint must bind (through the complementary slackness conditions of the Kuhn-Tucker theorem). In this case,  $\gamma$  may be solved to be

$$\gamma = \frac{1}{\left[ 4 - \frac{4Z}{\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2} \right]^{1/2}} \quad (5.67)$$

where  $Z$  is as defined previously.

The optimal rates of interest once we substitute in for  $\gamma$  in equations (5.65) and (5.66) are then as given in equations (5.49) and (5.50) for the general solution.

Finally, the debt issue decision may be formulated for Case 3 by substituting the optimal rate equations (5.65) and (5.66) into the debt issue inequality  $p + \alpha(r_{LM} - r_L) > q + \beta(r_S - r_{SM})$  or by inserting  $\lambda = 0.5$  into the general solution of (5.51) to give

$$D \stackrel{\geq}{=} 0 \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S) + (p - q) / (1 - 1/2\gamma)}{\alpha + \beta} \stackrel{\geq}{=} r_{DM} \quad (5.68)$$



Given that the profit constraint is binding, we may substitute in for  $\gamma$  (as defined in equation (5.47)) in equation (5.68), the optimal debt condition becoming that shown in the general solution of equation (5.52).

When there exists no constant term in the loan demand or deposit supply equations, or when the two constant terms  $p$  and  $q$  are identical, the decision to issue debt for both Cases 2 and 3 is identical to that of profit maximisation (Case 1). In addition, it is useful to note that if in Cases 2 and 3 the building society were to incur a level of expenditure equal to the maximum ceiling as derived in equations (5.56) and (5.57) for the profit maximising Case 1, then the optimal rates for both cases would be the same as those derived for profit maximisation.

Tables 5.6 and 5.7 below compare the optimal interest rates and debt issue conditions (respectively) for the three values of the behavioural motivation parameter ( $\lambda$ ) discussed above. These theoretical optimal mortgage and savings rate solutions and debt issue conditions turn out to be particularly interesting since for  $\lambda = 0.5, 1$  they are not dependent on the motivation weighting factor,  $\lambda$ . This implies that the motivation of the building society towards maximising either profits or member benefits plays no role in determining the optimal rates of interest on mortgage loans or deposits as set by the society or whether or not a society will issue debt when  $\lambda \geq 0.5$ . This finding allows us to conclude that a building society which is completely member oriented should not set its mortgage and savings rates any differently to a society in which profits and member benefits are allocated equal weights. However, we will see later in Section 5.3.3 that the nature of the mathematical model places restrictions on this conclusion.

**Table 5.6 : Summary of Optimal Interest Rate Setting Policy**

$\lambda = 0$	$\lambda = 0.5, 1$
$r_L^* = \frac{r_{LM} + r_{DM} + C_L}{2} + \frac{p}{2\alpha}$	$r_L^* = \frac{(r_{LM} + r_{DM} + C_L)}{2} + \frac{p}{2\alpha}$ $+ \frac{(r_{LM} - r_{DM} - C_L)}{2} \left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2}$
$r_S^* = \frac{r_{SM} + r_{DM} - C_S}{2} - \frac{q}{2\beta}$	$r_S^* = \frac{(r_{DM} + r_{SM} - C_S)}{2} - \frac{q}{2\beta}$ $- \frac{(r_{DM} - r_{SM} - C_S)}{2} \left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2}$

**Table 5.7 : Summary of Debt Issue Conditions**

$\lambda = 0$	$\lambda = 0.5, 1$
$D \stackrel{\geq}{\leq} 0 \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S) + (p - q)}{\alpha + \beta} \stackrel{\geq}{\leq} r_{DM}$	$D \stackrel{\geq}{\leq} 0 \text{ iff } \frac{\alpha(r_{LM} - C_L) + \beta(r_{SM} + C_S)}{\alpha + \beta} + \frac{(p - q)}{(\alpha + \beta)(1 - S)} \stackrel{\geq}{\leq} r_{DM}$

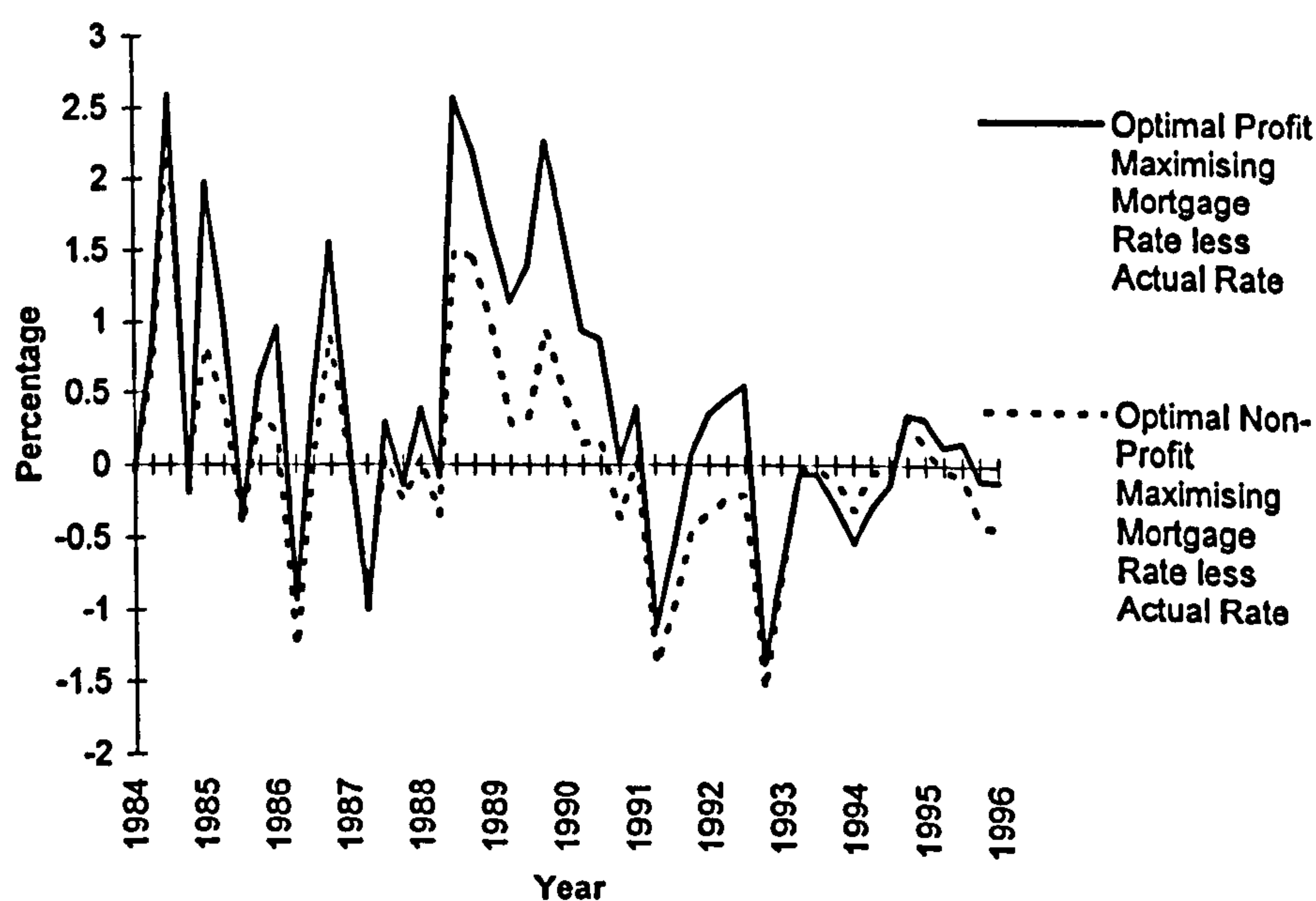
Finally, it is worth comparing the optimal rates of interest under assumptions about the value of the behavioural parameter,  $\lambda$ . When  $\lambda \geq 0.5$ ,  $r_L^*$  will always be less than the profit maximising level of  $r_L^*$  if we assume that  $(r_{LM} < r_{DM} + C_L)$  and also that we take only the positive root of the term in square brackets in equation (5.49). Equivalently, when  $\lambda \geq 0.5$   $r_S^*$  will always be greater than the profit maximising level of  $r_S^*$  if we assume that  $(r_{DM} < r_{SM} + C_S)$  and also that we take only the positive root of the term in square brackets in equation (5.50). Indeed this is what could be expected, with a higher level of  $\lambda$  indicating a society is more member oriented and likely to have a higher rate of interest on savings and a lower mortgage rate. Over the period 1984Q1 to 1996Q1, the average rates of interest have been  $r_{LM} = 11.25$  per cent (banks average mortgage rate of interest),  $r_{DM} = 10.01$  per cent (three month sterling interbank rate) and  $r_{SM} = 9.04$  per cent (average gross rate on clearing banks' 90-day-



access savings accounts with medium balance). The inequality assumptions stated above will then hold empirically for  $C_L > 1.24$  per cent and  $C_S > 0.97$  per cent.

Using the above series for the observed exogenous interest rates and making a number of assumptions about  $C_L$ ,  $C_S$ ,  $\alpha$ ,  $\beta$ ,  $p$ ,  $q$  and  $\bar{E}$ , Figure 5.2 below plots the difference between the optimal and actual rates of interest on mortgages for both the profit maximising ( $\lambda = 0$ ) and the non-profit maximising cases ( $\lambda = 0.5, 1$ )<sup>28</sup>. The optimal rate of mortgage interest for the former case is constructed according to equation (5.54) and that of the latter case according to equation (5.49). Clearly, Figure 5.2 indicates that the performance of the non-profit maximising interest rate as defined by equation (5.49) is superior when considered over the *whole* period, tracking the *actual* rate of mortgage interest set by building societies more accurately than equation (5.54). However, Figure 5.2 suggests that the profit maximising mortgage rate of interest has become considerably more accurate since 1990 in tracking the actual rate, which is consistent with the observed movement of societies away from the ideal of maximising member benefits to one of profit maximisation.

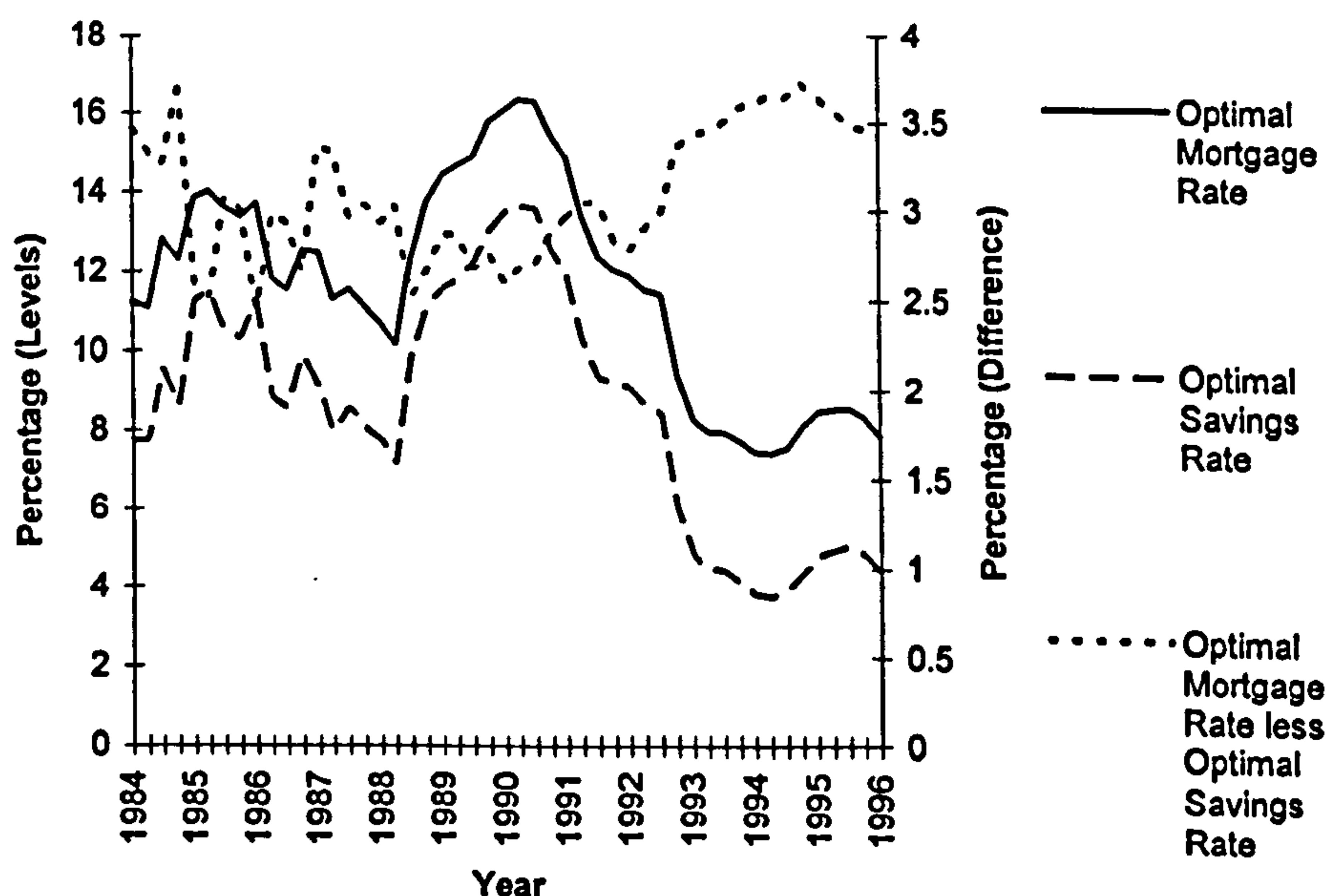
Figure 5.2 : Optimal Less Actual Mortgage Rates ( $r_L^* - r_L$ ) 1984Q1 to 1996Q1



<sup>28</sup> In Figures 5.2 through 5.4,  $r_L$  is taken to be the societies' average mortgage rate and  $r_S$  the average gross rate on building societies' shares and deposits.

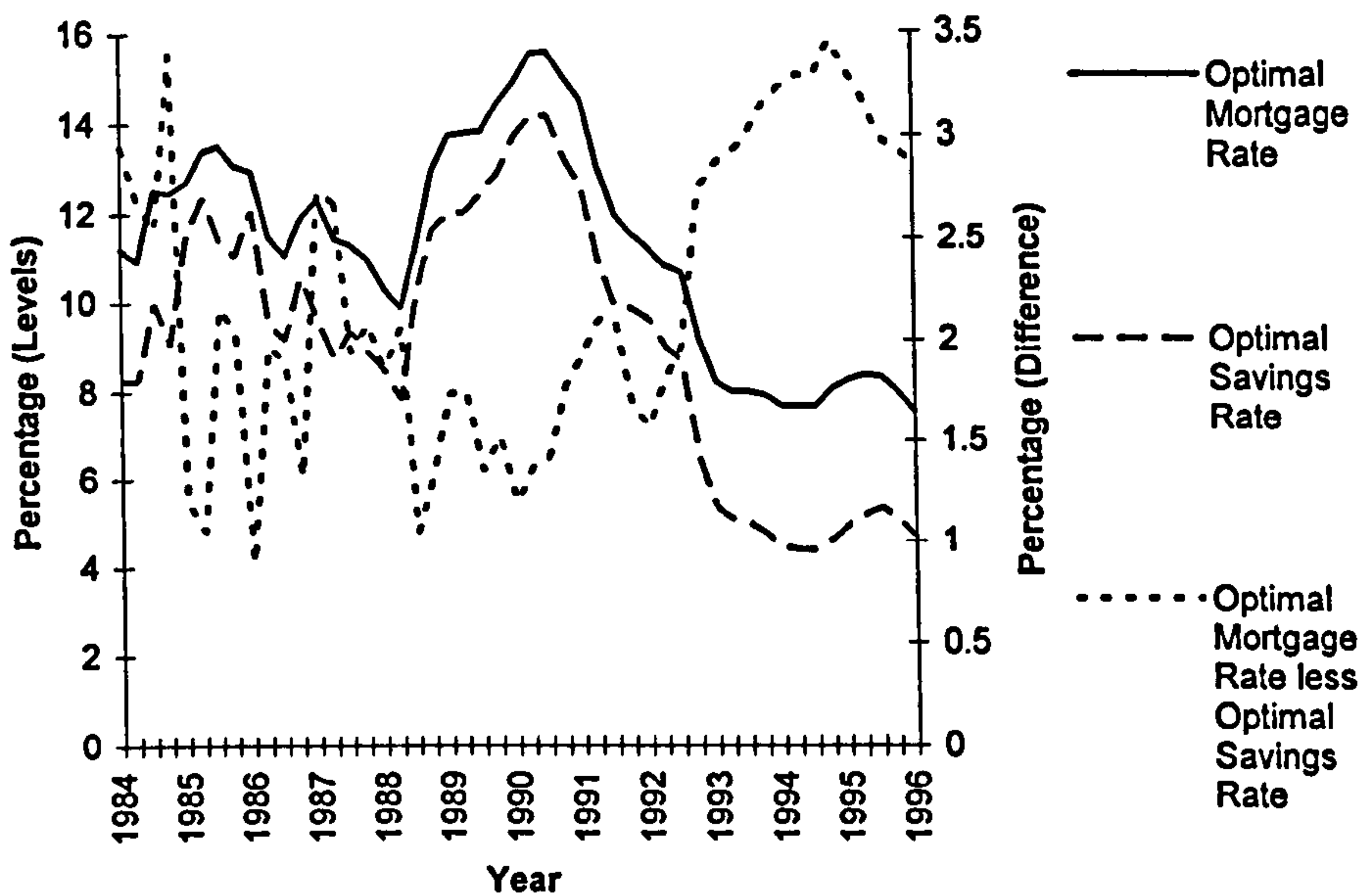
Figures 5.3 and 5.4 below graph the optimal mortgage and savings rates against each other for  $\lambda = 0$  and  $\lambda = 0.5, 1$  respectively. The optimal mortgage and savings rates are calculated using equations (5.54) and (5.55) for the profit maximisation case and (5.49) and (5.50) for the non-profit maximising cases in which  $\lambda = 0.5, 1$ . As expected, the difference between the optimal mortgage and savings rates when building societies are assumed to maximise profit is shown to be higher than the difference observed when member benefits feature in the objective function. As such, although the model suggests that building societies should not change their mortgage or savings rates when the behavioural parameter varies between 0.5 and 1, societies will alter their rates as  $\lambda$  heads from 0.5 towards 0 (i.e. as societies become profit maximisers). This finding clearly accords with the anecdotal evidence that, on conversion to Plc status, societies have raised their lending rates whilst simultaneously reducing their savings rates as the maximisation of profits becomes the overriding concern.

**Figure 5.3 : Optimal Mortgage and Savings Rates, Profit Maximising Case ( $\lambda = 0$ ), 1984Q1 to 1996Q1**





**Figure 5.4 : Optimal Mortgage and Savings Rates, Non-Profit Maximising Case ( $\lambda = 0.5, 1$ ), 1984Q1 to 1996Q1**



### 5.3.3 A Restriction on the Applicability of the Model

It turns out that an important problem is the way in which the value of  $\lambda$  affects the optimand function and the constraint defined in equations (5.20) and (5.21). The theory of Lagrange optimality requires that both the objective and constraint functions be concave (concave programming theory), which in turn requires their respective Hessian matrices of second derivatives to be negative definite. This does not cause a problem in the case of the profit function; it may be shown<sup>29</sup> that the Hessian matrix for the constraint equation is

$$H = \begin{bmatrix} \pi_{r_L r_L} & \pi_{r_L r_S} \\ \pi_{r_S r_L} & \pi_{r_S r_S} \end{bmatrix} = \begin{bmatrix} 2f'(r_L) & 0 \\ 0 & -2g'(r_S) \end{bmatrix} \quad (5.69)$$

on the assumption that  $f''(r_L) = g''(r_S) = 0$ . Since  $f'(r_L) < 0$  and  $g'(r_S) > 0$  from equations (5.18) and (5.19), the Hessian matrix defined in equation (5.69) for the non-

<sup>29</sup> See Appendix 5.2 Section A5.2.3 for details.

negative profit constraint must always be negative definite, irrespective of the value of  $\lambda$ <sup>30</sup>.

However, using the same assumptions about the second order derivatives as above (i.e.  $f''(r_L) = g''(r_S) = 0$ ), the Hessian matrix for the objective function may be written<sup>31</sup>

$$H = \begin{bmatrix} Q_{r_L r_L} & Q_{r_L r_S} \\ Q_{r_S r_L} & Q_{r_S r_S} \end{bmatrix} = \begin{bmatrix} f'(r_L)[2(1-2\lambda)] & 0 \\ 0 & -g'(r_S)[2(1-2\lambda)] \end{bmatrix} \quad (5.70)$$

where  $Q$  represents the objective function as defined in equation (5.20).

In this case, the Hessian will only be negative definite if we have  $2(1-2\lambda) > 0$  or  $\lambda < 0.5$ . To clarify the situation regarding the change in the objective function from being negative definite to positive definite when  $\lambda$  becomes greater than 0.5, it is informative to consider the original components of the objective function in equation (5.16). From equation (5.17),  $\pi$  can be shown to be concave in  $r_L$  and  $r_S$  (see Appendix 5.2 Section A5.2.3) whereas it is the case that (from equations (5.12) and (5.13))  $NGL$  and  $NGS$  are non-concave in  $r_L$  and  $r_S$  respectively (see Appendix 5.2 Section A5.2.2 for a formal proof). Thus when  $NGL$  and  $NGS$  carry a higher weight in the objective function of equation (5.16) than does profit (i.e.  $\lambda > (1-\lambda)$  or  $\lambda > 0.5$ ) the whole function flips from being concave to convex as the Hessian matrix becomes positive definite. Thus the conclusions drawn from the optimal equations (5.45) and (5.46) only hold for  $\lambda < 0.5$  and may or may not hold for  $\lambda > 0.5$ .

To elaborate mathematically on the problem of finding a solution when  $\lambda \geq 0.5$ , we know that in general the maximum of a continuous objective function on a bounded and closed feasible set must exist. If the objective function is smooth, then either the

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<sup>30</sup> For the Hessian to be negative definite we require that its principal minors alternate in sign. In the Hessian matrix of (5.69) in the text, this condition is simply that  $a_{11} < 0$  and  $\begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix} > 0$ , which is clearly satisfied.

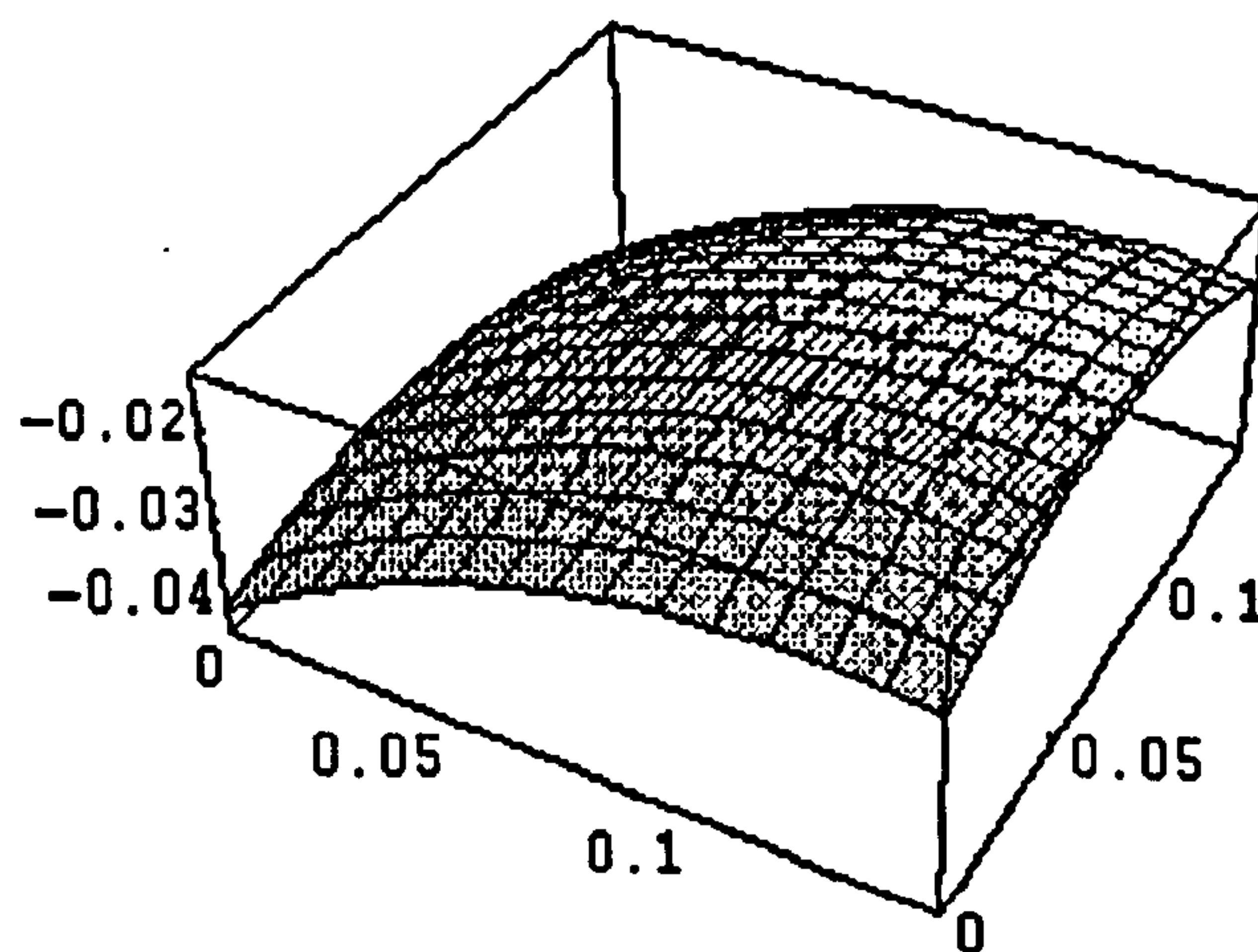
<sup>31</sup> See Appendix 5.2 Section A5.2.1 for a formal proof.



maximum occurs at a local maximum (given by the Lagrangian optimisation) or on the boundary of the feasible set. When  $\lambda$  changes from being less than to greater than 0.5, the Hessian matrix for the objective function turns from being negative definite to zero (at  $\lambda = 0.5$ ) to positive definite, and thus for  $\lambda > 0.5$  the Lagrange optimisation actually finds a local *minimum* of the objective function. From the theorem above, we therefore know that if a solution exists at all, it must be the case that it is a boundary solution.

To illustrate the optimisation problem graphically, it is possible to plot the objective function against the interest rates  $r_L$  and  $r_S$  on a three dimensional plane. Inserting values for the exogenous variables in the objective function (the rates of interest are taken to be the average rates as used in the previous section, i.e.  $r_{LM} = 11.25$  per cent,  $r_{DM} = 10.01$  per cent and  $r_{SM} = 9.04$  per cent, the non interest processing costs are assumed for ease of exposition to be  $C_L = C_S = 0.05$ , the parameters of the loan and deposit rate equations are set at  $\alpha = \beta = 1.2$ , the constants  $p$  and  $q$  are set to zero, and fixed expenditures are set at  $E = 0.015$ ), the plane of the objective function will vary with  $\lambda$  as shown in Figures 5.5 through 5.7 below. In each figure, the vertical axis represents the value of  $Q$ , the objective function, and the horizontal axes represent the levels of the interest rates  $r_L$  and  $r_S$ .

**Figure 5.5 : Objective Function Map for  $\lambda = 0$**



**Figure 5.6 : Objective Map for  $\lambda = 1$**

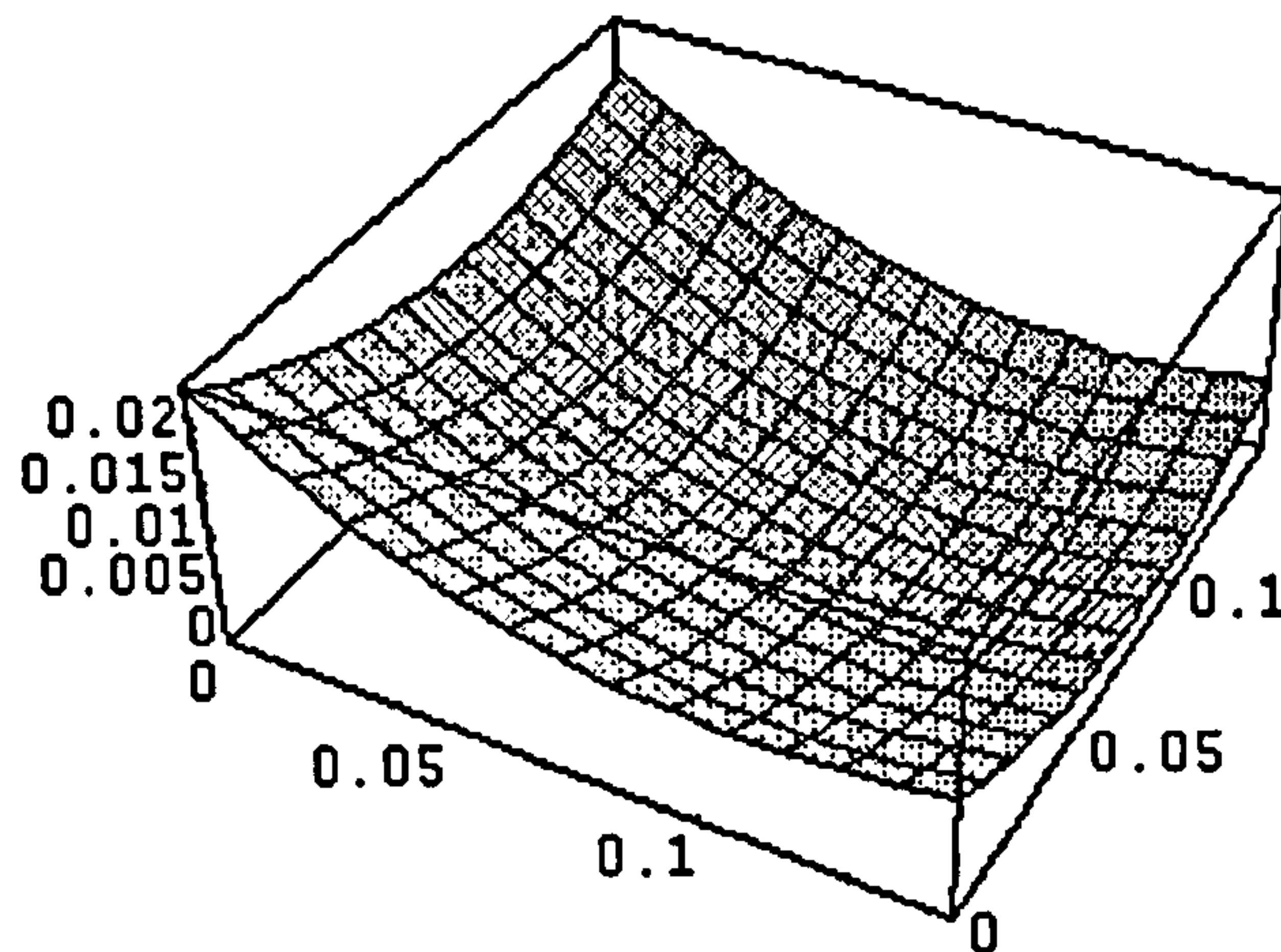
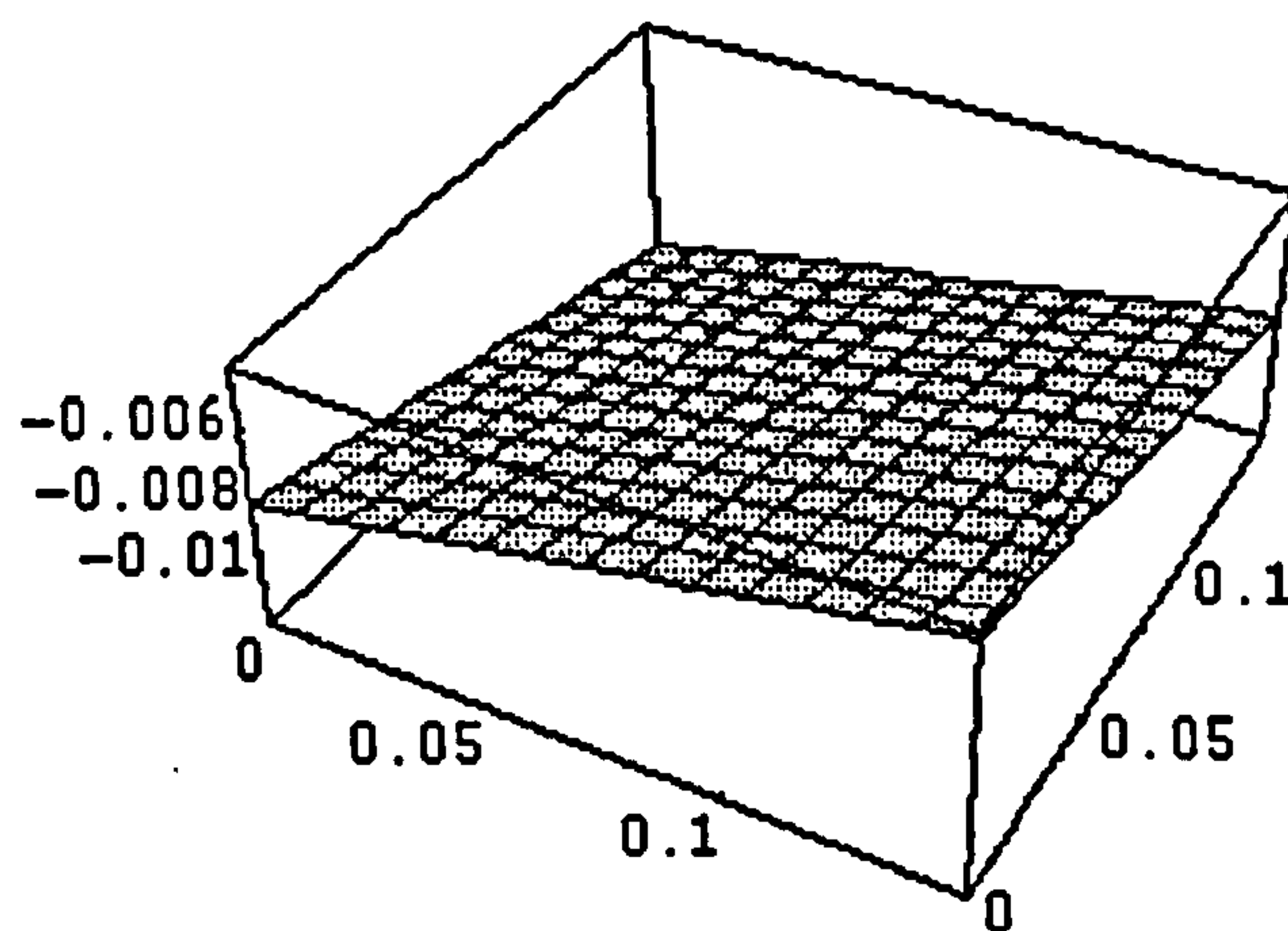


Figure 5.5 with  $\lambda = 0$  is clearly concave, as desired for the constrained optimisation. However, when  $\lambda > 0.5$  (e.g.  $\lambda = 1$  as in Figure 5.6) the function is clearly convex. Only where  $\lambda = 0.5$  does the function  $Q$  graph as a linear flat plane.

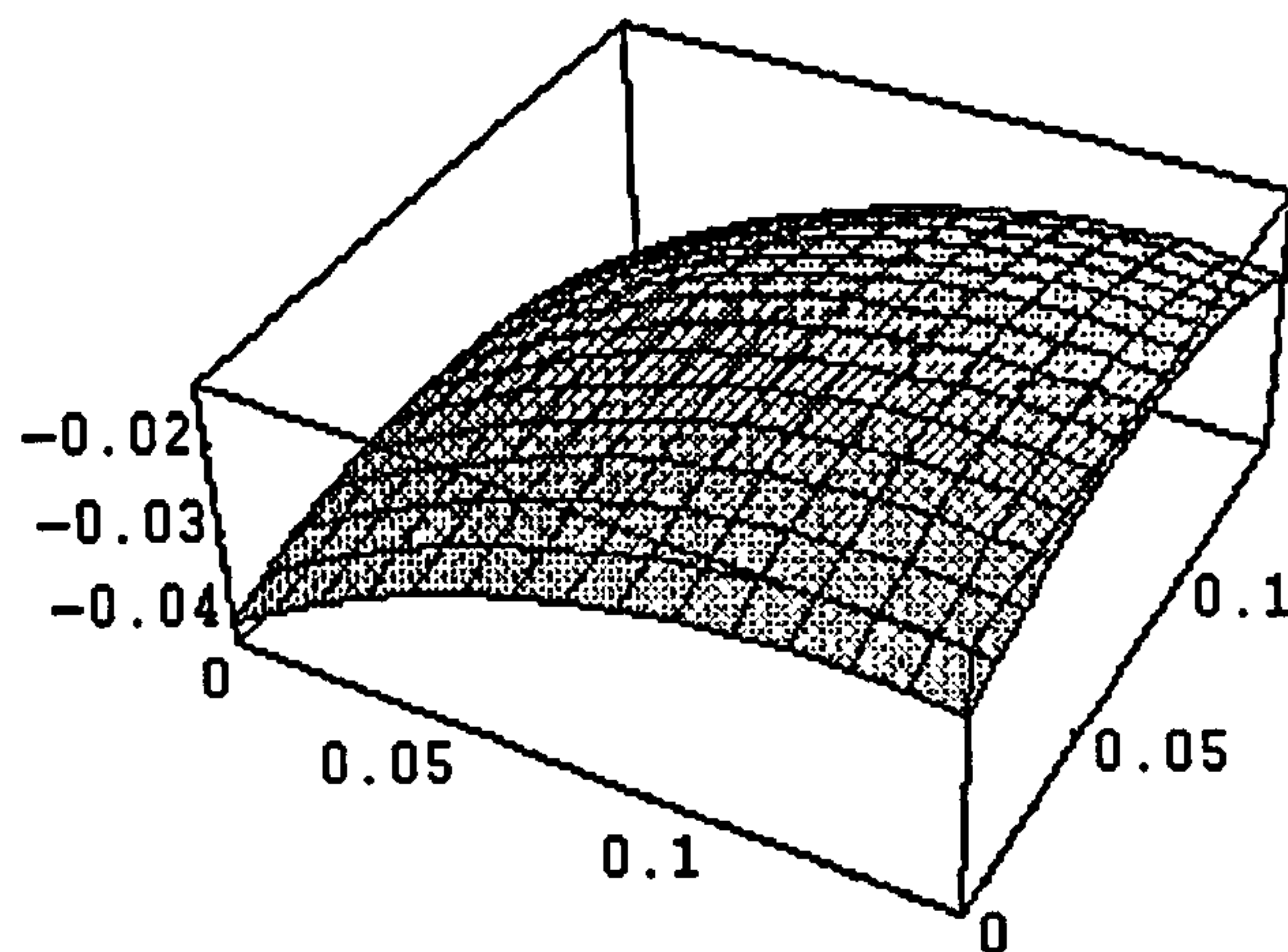
**Figure 5.7 : Objective Map for  $\lambda = 0.5$**



Finally, as discussed earlier, the constraint function is concave in the two interest rate variables  $r_L$  and  $r_S$  (shown below) irrespective of the value of  $\lambda$ .



**Figure 5.8 : Constraint Map ( $\lambda$  Irrelevant)**



The conditions under which the Lagrange theorem *does* maximise the objective function subject to the constraint when  $\lambda \geq 0.5$  may be verified by considering the determinant of the Hessian matrix of second order derivatives of the Lagrangian bordered by the first order differentials of the constraint function (with respect to  $r_L$  and  $r_S$ ). This determinant must be positive for maximisation, which may be shown to be the case<sup>32</sup> when we have

$$(1 - 2\lambda + \gamma) > 0 \quad (5.71)$$

or, on substituting in for  $\gamma$  from equation (5.47)

$$\lambda < \frac{2}{4 - \frac{1}{\left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2}}} \quad (5.72)$$

<sup>32</sup> See Appendix 5.2 Section A5.2.4 for a formal proof.

## 5.4 SUMMARY AND CONCLUSIONS

This chapter has considered a model in which building societies are assumed to choose their mortgage and savings interest rates in order to maximise a weighted function of member financial benefits and additions to reserves. The first two sections of the chapter analysed issues as to the specification of an objective function appropriate to the UK building society industry; in doing so, it proved informative to consider the theoretical literature on credit union interest rate setting. This literature provided an insight into the conflict between the borrowing and saving members of a society, an issue which dictates the precise nature of the building society's objective function. The theoretical arguments for the neutrality of societies with respect to the disbursement of financial benefits to borrower and saver members were generally supported by mixed empirical evidence; using UK building society microeconomic data for 1995, the methodology of Smith (1986) suggests that neutrality is observed whereas that of Patin and McNiel (1991) implies that net saver benefits from transacting with a building society rather than with an alternative financial institution were marginally (although significantly) higher than borrowers' financial benefits.

In the theoretical model of building society interest rate setting of Section 5.3, the results of a model in which the demand for mortgages and supply of deposits of building societies is assumed simply to be dependent *in general* on the relevant own rates of interest are presented. Then, specific loan demand and savings supply schedules are specified allowing us to derive optimal interest rate equations which are dependent on the parameters of the demand and supply functions and a number of exogenous interest rate variables. It is shown that under certain circumstances the interest rate decision of the building society will not depend on the extent to which that society is oriented towards either profit maximisation or the maximisation of member benefits. Specifically, when the building society operates predominantly to maximise member benefits, any move towards profit maximisation is shown to have no effect on the optimal mortgage and savings rates set by the society. When profit maximisation becomes the overriding objective interest rates *will* change; in general, the mortgage rate in this case will rise and the savings rate will fall as member



benefits drop out of the objective function and the society becomes a pure profit maximiser. However, the final section of the chapter shows that this conclusion is restricted somewhat by the nature of the mathematical model.

## CHAPTER 6

### Aggregate Time Series Data

#### 6.1 INTRODUCTION

In the previous chapters, theoretical models of the demand for housing and the supply of building society mortgage finance have been presented, both suggesting a number of variables which could be expected to be influential in estimating an empirical model of the mortgage market. Following the discussion of a fairly standard model of the demand for mortgage finance, this chapter rigorously examines the data set to be used in the subsequent empirical estimations of the equilibrium quantity of mortgages traded in Chapter 7<sup>1</sup>.

The remainder of the introduction is devoted to setting the scene, briefly examining the relative importance of banks and building societies in the provision of mortgage finance and the way in which the three primary endogenous variables in the system (namely the quantity of mortgages traded, the mortgage interest rate and the loan to value ratio) have behaved over the period of estimation.

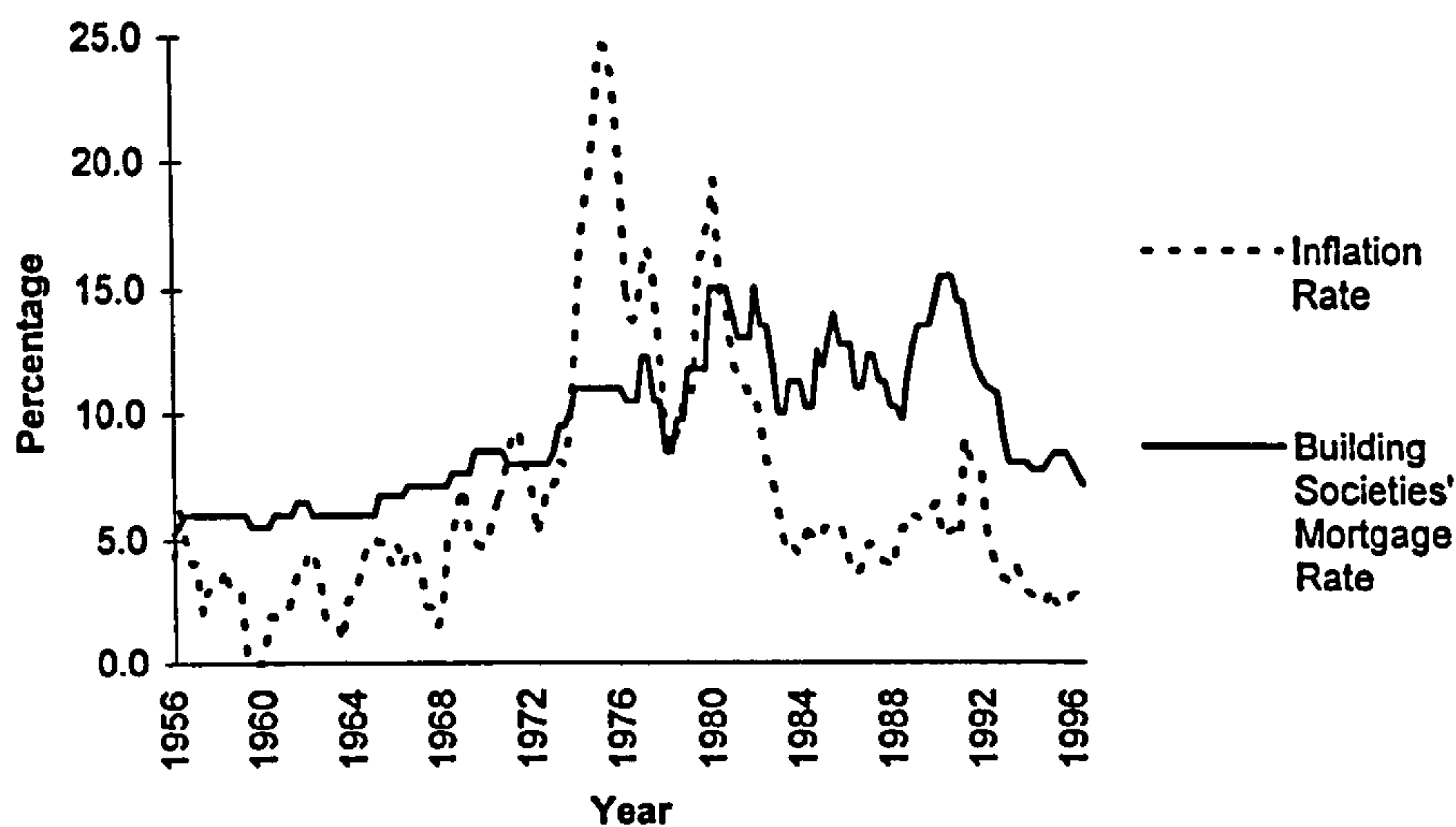
The pattern of building society interest rate setting over the past 40 years is shown in Figure 6.1 below. Prior to 1984, the Building Societies Association (BSA) operated a cartel arrangement through which it would announce recommended mortgage interest rates which were then adhered to by its members (consisting of the majority of UK building societies). It was the policy of the cartel to recommend rates that were considered stable in relation both to other rates of interest and the rate of inflation, a policy which can be clearly observed in the figure. Between 1974 and 1978 the BSA's recommended rates remained remarkably stable in spite of massive inflationary pressures. Real interest rates became highly negative, reaching an all time low of -15.5 per cent in the third quarter of 1975.

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<sup>1</sup> Discussion of the specification of the model and method of estimation are reserved for Chapter 7.



**Figure 6.1 : Building Societies' Mortgage Rate of Interest and the Inflation Rate**

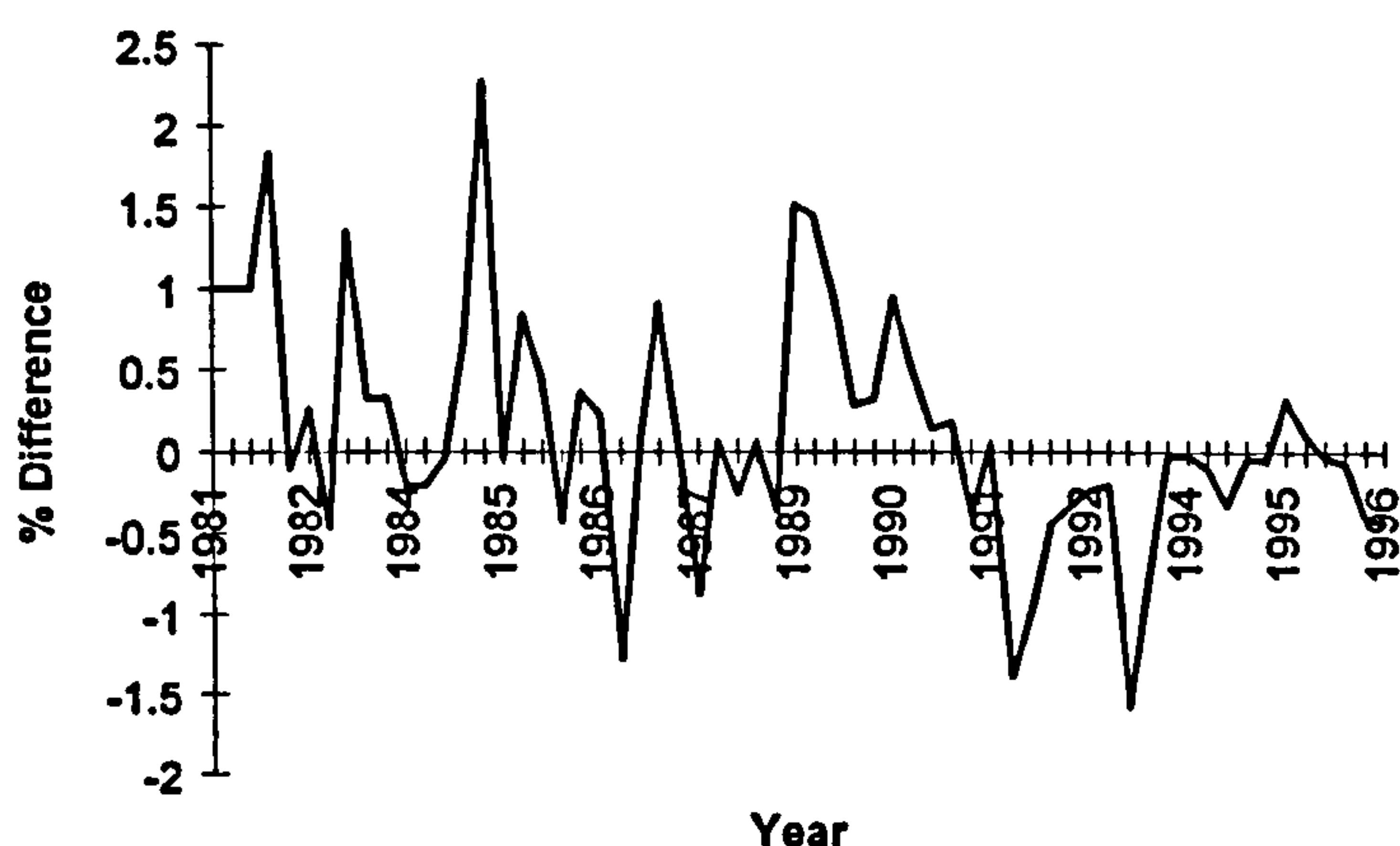


Following the breakdown of the BSA recommended rate system in 1984 and the increased involvement of banks in the mortgage market, competition within the market grew and building societies realised that they had to become more competitive in setting interest rates. The figure shows that during this period mortgage rates began to track the rate of inflation more closely, with higher real interest rate costs being passed on to the consumer rather than being borne by the societies. This may be shown by examining the correlation coefficient between the mortgage interest rate ( $r_m$ ) and the rate of inflation ( $\pi$ ) (calculated as  $\text{Cov}(r_m, \pi) / \sigma_{r_m} \sigma_{\pi}$ , where  $\text{Cov}$  is the covariance between the two variables and  $\sigma$  the standard deviation of each), which between 1984Q1 and 1997Q1 stood at 0.85; over the whole sample period 1963Q1 to 1997Q1 the coefficient was less than 0.5.

The period since 1980 has been one of considerable financial market re-regulation, with legislation being enacted to free the mortgage market from the lending controls which had served to exclude non-mutual organisations from lending for the purchase of private housing. As we saw in Chapter 2, the resultant increased competition in the mortgage market was inevitable as the removal of lending restrictions encouraged non-mutual organisations to become more active in the market. This is illustrated in Figure 6.2 below which shows the percentage difference between bank mortgage rates

(averaged over 8 major banks) and those offered by building societies (averaged over the top 20 building societies).

**Figure 6.2 : Percentage Difference Between Bank and Building Society Mortgage Interest Rates**



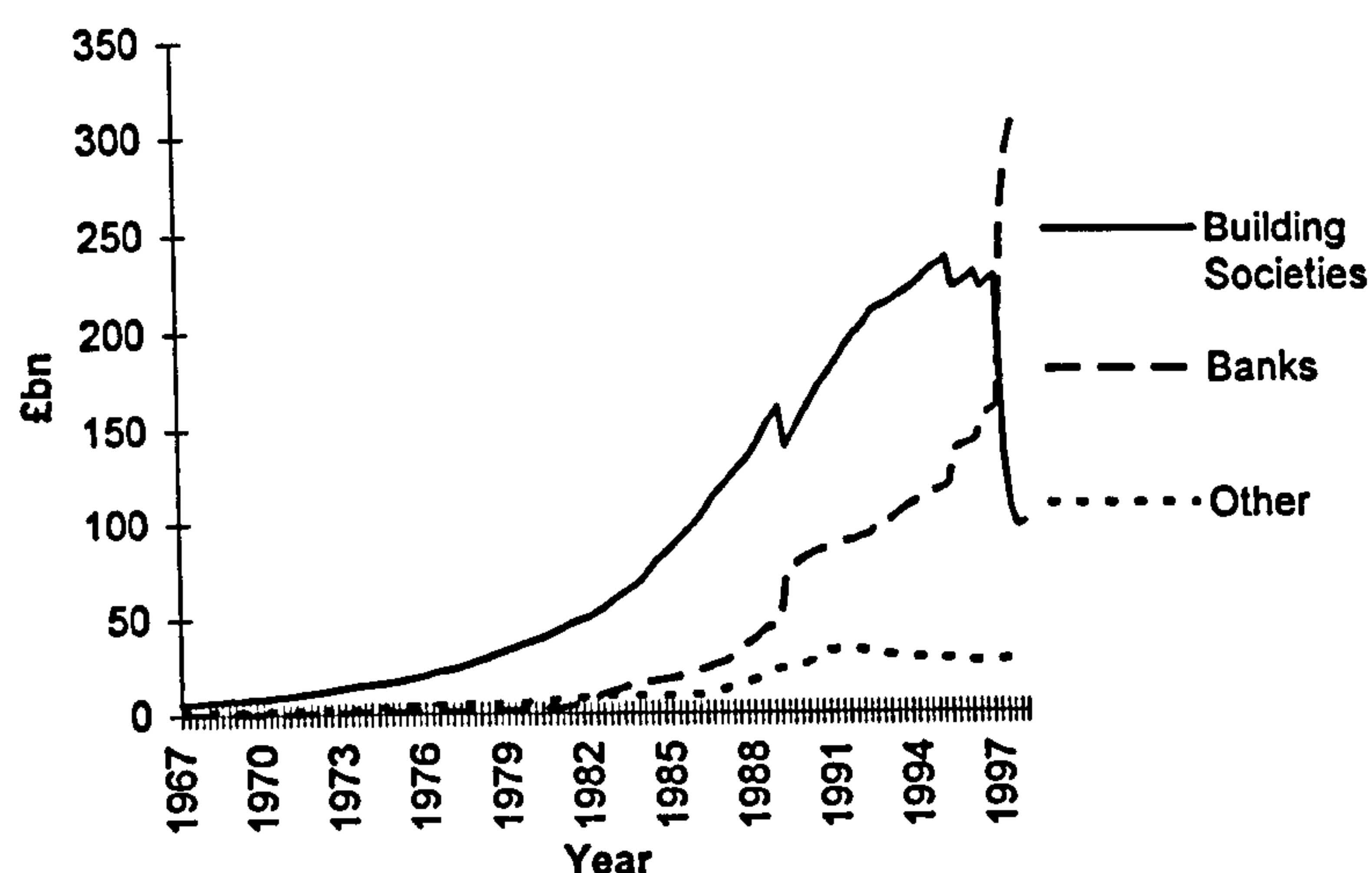
It is clear from Figure 6.2 that banks have slowly begun to compete more effectively on price terms (mortgage interest rates) in the market for mortgage finance. During the majority of the 1980s, banks had found themselves offering higher mortgage rates than building societies, and it is only as recent as the 1990s that banks have been able to consistently offer more competitive mortgage rates of interest. The vigour with which banks began to accumulate mortgage business in the early 1980s can be seen in Figure 6.3 below.

In Figure 6.3 below, the significant positive changes to banks' outstanding mortgages accompanied by commensurate reductions in those of building societies in periods 1989Q3, 1995Q3, 1996Q3 and 1997Q2-4 have occurred as the result of the conversion of a number building societies to bank (public limited company) status (see Appendix 2.1). The 'other' category represents loans on dwellings by central government, local authorities, public corporations, insurance companies and pension funds and miscellaneous financial institutions (the largest component of the latter being bank subsidiaries). Such institutions have experienced a declining influence in the mortgage market, with outstanding mortgage lending falling from almost 25 per

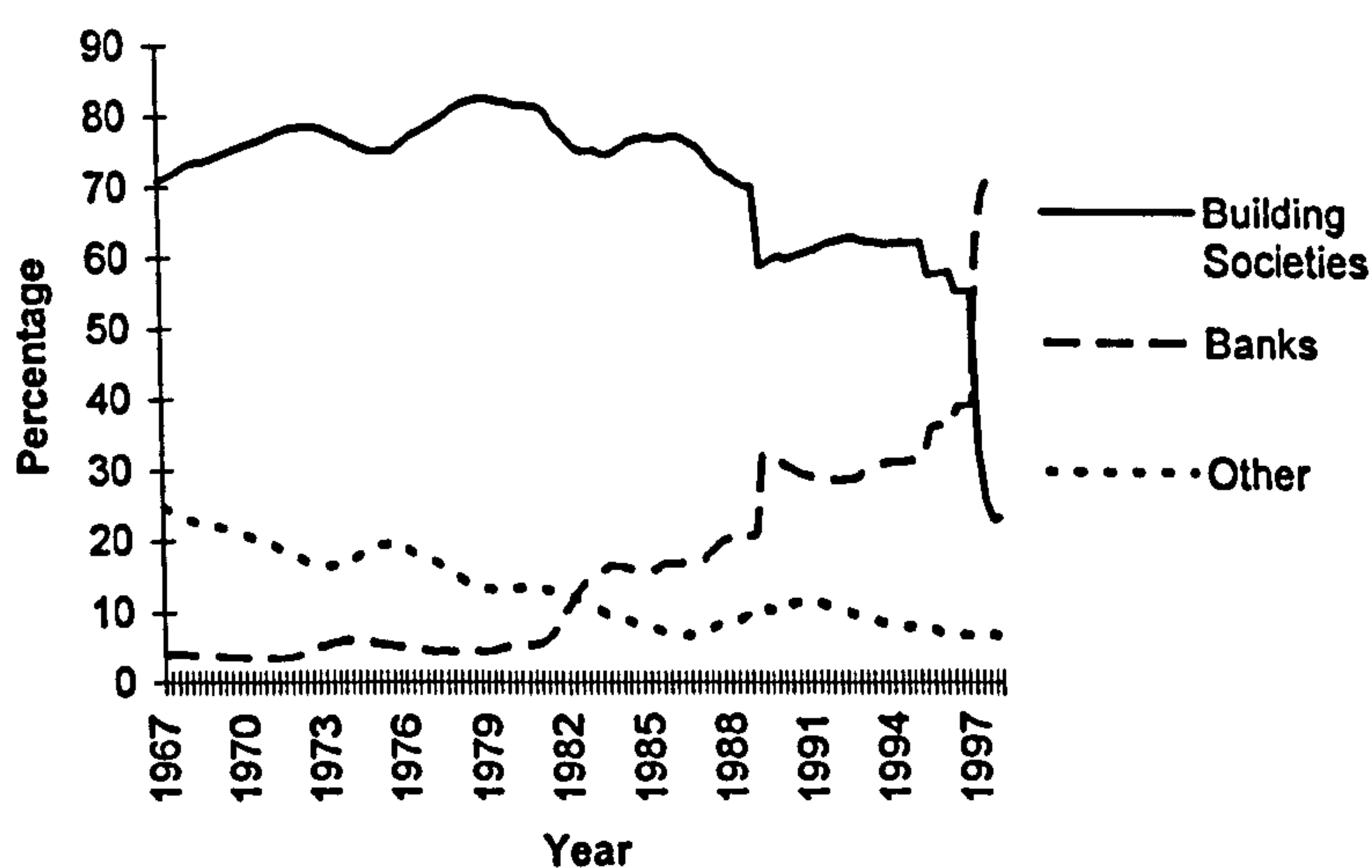


cent in the first quarter of 1967 to under 6.5 per cent in the first quarter of 1998, a trend which may be seen more clearly in Figure 6.4. Within the group, insurance companies and pension funds have suffered the most significant fall from a position of owning a larger than 12 per cent share of the market in the first quarter of 1967 to only 0.4 per cent in the first quarter of 1998.

**Figure 6.3 : Loans Outstanding on Dwellings by Financial Institution, £bn**



**Figure 6.4 : Loans Outstanding on Dwellings by Financial Institution, per cent**



Finally, the loan to value ratio (see Figure A6.1.3 of Appendix 6.1) has been considerably higher during the 1980s than it was for the whole of the 1970s, the latter

being a period in which mortgages were severely rationed. In addition, during the 1970s the loan to value ratio was relatively volatile, its seasonally adjusted value ranging from a high for the decade of 82.5 per cent in the first quarter of 1972 to an all time low of 71.6 per cent in the second quarter of 1974, a dramatic change of 10.9 percentage points in only two and a half years. The 1980s witnessed a stabilisation of the ratio at an average of just over 83 per cent for the decade, following which it rose dramatically by more than 9 percentage points during the two year period between the third quarter of 1993 and the same quarter of 1995.

The next section of this chapter briefly discusses the important theoretical results for mortgage supply derived in Chapter 5 and proposes the preferred model of mortgage demand, following which Section 6.3 investigates a number of issues regarding the general specification of the variables, including the method of seasonal adjustment, interpolation and the use of real (as opposed to nominal) variables. Section 6.4 then focuses on variable choice and construction and Section 6.5 present formal tests to examine the time series properties of the data. Section 6.6 then summarises and concludes the chapter.

## **6.2 THE THEORETICAL BASIS**

In this section, we discuss the theoretical functions for the supply of mortgage finance derived in Chapter 5 and also outline the preferred model of mortgage demand as recently proposed by Jones (1993, 1995). These theoretical foundations will provide a useful insight into the specification of the empirical relationships to be estimated in Chapter 7.



### 6.2.1 The Supply of Mortgage Finance

The theoretical model of building society behaviour presented in Chapter 5 suggests that a building society's optimal strategy in setting the level of its mortgage interest rate is governed by equation (6.1) below<sup>2</sup>

$$r_L^* = \frac{(r_{LM} + r_{DM} + C_L)}{2} + \frac{p}{2\alpha} + \frac{(r_{LM} - r_{DM} - C_L)}{2} \times \left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2} \quad (6.1)$$

where the notation is defined fully in Chapter 5. Given that the empirical analysis of the following chapter will be concerned with the factors acting to determine mortgage supply (and indeed demand), we will need to be able to write the above equation as a supply function for mortgage finance. To do so requires an assumption about the relationship between the endogenous mortgage rate of interest set by the building society ( $r_L^*$  in equation (6.1) above) and the quantity of mortgages that the society is willing to supply at that particular rate. Although the model would suggest that mortgage supply is independent of  $r_L^*$  (since quantity supply does not appear in equation (6.1)), the model is very simplistic and it may be reasonably assumed that the higher is the optimal mortgage rate, the greater will be the willingness of any particular building society to lend mortgage funds, and *vice versa*. With mortgage supply a positive function of the rate of mortgage interest set by the building society, a change in any of the exogenous variables which affect the optimal rate of interest will have an effect of the same sign on the mortgage supply schedule. Thus the society will make a decision as to the level of its mortgage interest rate according to the relationship of equation (6.1), this rate then determining the amount of mortgage lending the society is willing to undertake.

In practice, following an increase (decrease) in the mortgage rate of interest offered by the society to purchasers of real estate, mortgage supply may be expanded

<sup>2</sup> This is true on the assumption that member benefits are at least as important as profits in the society's objective function.

(constrained) by use of the 'non-price' terms of the mortgage contract (denoted by vector  $\mathbf{v}$  in equation (6.2) below) such as the loan to value or loan to income ratio. The precise use of such terms will be considered in more depth in Chapter 7, but at this point it is suffice to acknowledge the existence of three endogenous variables in the mortgage supply relationship : the optimally set mortgage rate of interest, the resulting desired supply of mortgage finance and the non-interest terms of the loan. This allows us to specify the building societies' mortgage supply function as

$$M_{BSi}^s = f(r_L, r_{LM}, r_{DM}, r_{SM}, C_L, C_S, \mathbf{v}) \quad (6.2)$$

However, in empirically specifying the relationship it is likely that the four interest rate variables will be highly collinear and the cost of processing loans and savings accounts ( $C_L$  and  $C_S$  respectively) reasonably constant over the period of estimation in which we will be primarily interested (1984Q1 to 1995Q4). This would imply that building societies' mortgage supply will be dependent only on the mortgage rate of interest and the non-price terms of the loan; it may also be postulated that mortgage demand will depend on these variables too, implying that the usual order condition for identification of the demand function will not be satisfied. Thus, mortgage supply must be assumed to depend on a number of other variables which, as we will see in Section 6.4, will be suggested from previous empirical literature on the supply of mortgage finance.

### 6.2.2 The Demand for Mortgage Finance

This section discusses the preferred model of mortgage demand proposed by Jones (1993, 1995). Various models of the demand for mortgage finance have been suggested in the literature, many of which are *ad hoc* and on the whole unsatisfactory<sup>3</sup>. Some papers model the demand for mortgage credit as a partial

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<sup>3</sup> It is proposed by Jones (1993, 1995) that a reason for the lack of theoretical models of mortgage loan demand stems from the common assumption that such demand is derived directly from the demand for housing; a standard hypothesis falling under this classification of model is that the household will borrow up to the limit of their housing collateral. Although to some extent this is true, it is not by any means the whole story as a growing number of households refinance by increasing their holdings of mortgage debt. Not only is additional finance used for capital improvements but also it is often used to support non-housing investment and consumption.



adjustment mechanism, in which the flow demand for mortgage finance is assumed to be a function of the difference between the desired level of mortgage debt and the level of debt outstanding. Examples include Huang (1966), Silber (1968), Kent (1980, 1981) and Askari (1986) among others. Little or no theoretical justification is provided for the inclusion of variables in the equations describing the optimal level of mortgage debt and as such the resultant parameterised demand equations and subsequent estimations are somewhat atheoretic. Other studies such as O'Herlihy and Spencer (1972), Smith (1979) and Wilcox (1985) are even less specific, presenting almost purely econometric specifications of mortgage demand. Variables alleged to be important in influencing demand in these papers are invariably based on a considerable degree of speculation.

Jones (1993, 1995) updates the work of Ranney (1981) to provide a basis for identifying the level of mortgage debt derived directly from the optimal quantity of owner occupied housing demanded. The model represents a substantial improvement over alternative 'linkage hypotheses' which view the demand for mortgage finance as inextricably based upon the value of the housing collateral<sup>4</sup>. There are a number of drawbacks associated with the linkage approach. Firstly, the optimisation process is usually based upon the determination of the quantity of housing alone whereas in reality, the desired mortgage loan and quantity of housing are chosen simultaneously. To address this problem, Jones (1993, 1995) proposes a life cycle model in which both the demand for housing and mortgage finance are determined simultaneously at the date of house purchase. Secondly, since models that assume debt maximisation are implicitly based upon the behaviour of first time buyers, they do not address debt demand subsequent to the house purchase. Finally, linkage theories recognise neither the possibility that mortgage funds may be used to finance investment in non-housing assets nor the use of non-mortgage debt to finance the purchase of the housing asset.

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<sup>4</sup> Kent (1980, 1981) recognises that it is the underlying demand for housing services that drives the demand for mortgage loans. As such, he derives an expression for the implicit rental price or user cost of housing using a consumer choice theoretic framework in which consumers are assumed to maximise their utility over consumer goods/services and housing services. However, in both papers the fact that this user cost is included without justification in a partial adjustment model undermines the work substantially.



In Jones' model, households are assumed to maximise lifetime utility under perfect certainty where the life cycle runs from the date of house purchase ( $t = 0$ ) to the date of retirement ( $t = T$ ), at which point the house will be sold. The size of house purchased ( $H$  units) at time  $t = 0$  is endogenous to the model whereas the purchase price of each unit ( $P_{H0}$ ), selling price ( $P_{HT}$ ) and the dates at which the decisions are made to buy and sell are determined exogenously. The housing asset produces a continuous stream of housing services denoted  $h$  at a constant rate of  $\phi$ , i.e.  $h = \phi H$ .

A mortgage loan to fund the house purchase is available at a constant exogenous after-tax rate of  $r_m$ <sup>5</sup> with mortgagors facing after-tax interest-only payments of  $r_m M$  from 0 to  $T$  (where the loan principal,  $M$ , is defined as  $M = mP_{H0}H$  with  $0 \leq m \leq 1$ ) at which point the principal is repaid<sup>6</sup>. The loan to value ratio is represented by  $m$  which is chosen by the household subject to the constraint that it cannot exceed the institutionally imposed maximum of, say,  $\beta$ <sup>7</sup>. Initially, the optimal mortgage debt ( $M^*$ ) is determined under the restriction that  $m = m^*$  is constant over the horizon  $0 < t < T$ ; no additional mortgage financing is available, implying  $M$  will remain in effect until repayment at time  $T$ <sup>8</sup>. The house purchase is financed by an endogenously chosen combination of mortgage debt and the household's initial endowment of

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<sup>5</sup> It is assumed that households may only borrow against housing collateral. It is also assumed that the supply of other credit is zero, which is equivalent to making the less restrictive assumption that alternative finance is available at a higher rate of interest of  $r_d > r_m$ . So, in principle households may finance the house purchase using non-mortgage debt, although the cost of credit in this case is so high that no household will use it. As a result, the non-mortgage debt financing of the purchase of the housing asset is suboptimal.

<sup>6</sup> This assumption is in contrast to Ranney (1981) who assumes that the mortgage contract is continuously amortising over the period  $0 < t < T$ , i.e. repayment of mortgage debt and interest at a constant rate from 0 to  $T$ . Jones argues that an interest-only mortgage enables both the identification of the cost of debt with the payment rate and allows us to associate all changes in mortgage debt balances with explicit recontracting decisions.

<sup>7</sup> Nor can the value of  $m$  fall below zero, implying that mortgage debt cannot be 'shorted'. Jones makes the assumption that  $\beta = 1$  implying that there are no downpayment constraints imposed by lenders; mortgage borrowing is then purely demand determined. However, it must not be overlooked that downpayment constraints (implying a value for  $\beta$  of strictly *less than* one) have long been a feature of the UK mortgage market. In fact such requirements were particularly severe during the 1970s with the loan to value ratio reaching an all time low of 71.6 per cent in 1974Q2.

<sup>8</sup> A justification for this assumption is that the costs of selling the house are prohibitively high enough to be such that it is not sold until retirement. However, Jones goes on to show in his paper that under costless mortgage recontracting, the results discussed in this section will hold even when households are permitted to alter their mortgage holdings *during* the life cycle.



wealth,  $W_0$ . Any income remaining after each period's repayment is either saved or spent on other goods and services.

In the model, a utility function ( $U$ ) is specified in continuous time in which household lifetime utility is derived from the consumption of housing services and of non-housing goods and services ( $C_t$ ) between periods 0 and  $T$ . The utility derived from net retirement wealth ( $W_T$ )<sup>9</sup> is measured by a function  $F$  which, like  $U$ , is assumed to be increasing, twice differentiable and concave. The household's problem is then to choose the size of the house and the quantity of mortgage debt in time 0 to maximise

$$\int_0^T U(h_t, C_t) dt + F(W_T) \quad (6.3)$$

subject to

- (i)  $S_0 = W_0 - (1-m)P_{H0}H$  with  $S_0 \geq 0$
- (ii)  $S_t > 0$  for  $0 < t < T$
- (iii)  $0 \leq m \leq 1$
- (iv)  $h_t = \phi H$
- (v)  $dS_t / dt = E_t + rS_t - r_m(mP_{H0}H) - p_t C_t$
- (vi)  $W_T = S_T + (P_{HT}H - M)$

where  $W_0$  and  $S_0$  represent the stock of non-housing wealth immediately prior to and after the house purchase respectively,  $S_t$  is the household's stock of wealth exclusive of housing equity and mortgage debt for  $t > 0$  (upon which an exogenous after-tax rate of return of  $r$  is earned),  $E_t$  represents labour income and  $p_t$  is the exogenously determined price of non-housing consumption ( $C_t$ ).

The first of the above constraints defines the stock of savings immediately after the house purchase (which is assumed to be non-negative) as the household's initial wealth less the downpayment on the house (the non-mortgaged portion of the house value). The second restriction requires savings to be strictly positive up until retirement, implying that the stock of accumulated savings must always be greater

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<sup>9</sup>  $W_T$  is composed of the value of accumulated non-housing financial assets plus the net proceeds from the sale of the house.

than zero subsequent to  $t = 0$ <sup>10</sup>. The importance of this assumption for the modelling of the dynamic problem is considered in more depth below. Restriction (iii) maintains that the loan to value ratio ( $m$ ) cannot be less than zero or greater than unity and restriction (iv) says that the flow of housing services at time  $t$  is equal to a pre-specified fraction of the size of the house purchased. The fifth restriction represents the budget constraint following the house purchase in which per period saving is equal to labour income ( $E_t$ ) plus the return on non-housing ( $rS_t$ ) less mortgage repayments ( $r_m(mP_{H0}H)$ ) and other non-housing consumption ( $p_tC_t$ ). The final restriction defines real retirement wealth ( $W_T$ ) as the stock of savings at retirement plus the sale value of the house minus the repayment of the mortgage principal,  $M$  (the final term of the equation in parentheses indicating either positive or negative housing equity).

To explain assumption (ii) intuitively, in conventional life cycle models with perfect capital markets, households can borrow and lend at the same interest rate in order to achieve an optimal path for life time consumption. Subject to the present value of its lifetime income, the household can make use of the capital markets to create any intertemporal income stream it desires in order to maximise utility. In such cases, therefore, the *distribution* of household income over the life cycle is irrelevant and only the present value of the income stream matters in the optimal allocation of expenditure between the stream of consumption ( $C_t$ ) housing services ( $h_t$ ) and net wealth at retirement ( $W_T$ )<sup>11</sup>.

However, in Jones' (1993, 1995) model, capital markets are *imperfect* since borrowing and savings rates are allowed to differ. In order that the same simplification may be made as in the perfect markets case above (i.e. that we may ignore the distribution of income over the household's lifecycle), we must make assumption (ii) which forbids households to borrow against future income in any

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<sup>10</sup> With  $r_d > r$  these first two assumptions effectively prevent households from holding non-mortgage consumer debt.

<sup>11</sup> Fu (1995), for example, presents a 2 period certainty equivalent model in which the time path of income *is* important in affecting the demand for housing when capital markets are imperfect.



period<sup>12</sup>. By credibly assuming away the role of the time path of income, we allow the problem to be reduced to one of static optimisation<sup>13</sup>.

As a result of the maximisation process, Jones (1993, 1995) goes on to show that the optimal amount of mortgage debt demanded by households is driven by the relationship between  $r_m$  and  $r$  (the rate of interest on mortgage loans and the rate of return earned on non-housing assets respectively, both after-tax). If  $r_m < r$ , households will optimise by *maximising* their mortgage borrowing (subject to the constraints set out above, and in particular the loan to value restriction) because in this case, the cost of using mortgage lending to fund the purchase of the house is lower than the opportunity cost of using one's own financial wealth. In the UK, the erosion of the tax deductibility of mortgage interest payments under the Mortgage Interest Relief at Source (MIRAS) scheme over the last decade has clearly reduced the likelihood of this situation (see Figure 2.11 in Section 2.5 of Chapter 2). Alternatively, when  $r_m > r$  optimisation implies mortgage debt *minimisation*. In this case households will fund as great a portion as possible of the value of the house purchased by means of their personal wealth and the remainder by mortgage finance; as such, the equation for the optimal demand for mortgage finance as suggested by Jones may then be written as

$$M^*(H^*)_t = \begin{cases} 0 & \text{if } W_t \geq P_{Ht} H^* \\ P_{Ht} H^* - W_t & \text{if } W_t < P_{Ht} H^* \end{cases} \quad (6.4)$$

The mortgage rate stability of the mid-1970s in the face of spiralling inflation meant that real mortgage interest rates over this period were substantially negative; if during this period rates of return on non-housing assets varied with the rate of inflation such that the real return to savings remained constant, we would expect there to be a greater chance that  $r_m < r$  and the validity of equation (6.4) above must be questioned.

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<sup>12</sup> The constraint must be strictly positive since a level of savings of zero could obviously still be consistent with the desire to borrow.

<sup>13</sup> Non-negative savings per period may indeed be justified if we are dealing with households that have already decided to become homeowners, since they will have reached the stage in their life cycle where they are saving for retirement (and thereby desiring to hold positive net wealth).

Indeed, the inclusion of a measure of personal wealth in the estimated demand function for mortgage finance will allow us to test Jones' theory; one would expect a higher positive or lower negative coefficient on the wealth variable in estimations undertaken on a data sample in which there existed a regime of higher inflation. The reason is that when nominal mortgage interest rates were sticky during the 1970s, high rates of inflation brought about a fall in the differential between the mortgage interest rate and the rate of interest on non-housing financial wealth (the latter adjusting more flexibly with inflation) encouraging the use of maximum quantities of mortgage debt. It would then have been less likely that the theoretical predictions of equation (6.4) that mortgage debt and financial wealth are substitutes would have held, thus reducing any negative impact of higher financial wealth on mortgage demand.

The demand for mortgage debt may be specified empirically by assuming that the optimal level of housing demand ( $H^*$ ) which appears in equation (6.4) may be written as follows

$$H_t^d = f_d(R_t, Y_{pt}, DEM_t) \quad (6.5)$$

Equation (6.5), which is derived in Section 4.2.1 of Chapter 4, specifies the demand for housing as a function of the real rental price of housing services (and thus the real user cost of housing capital), real permanent income<sup>14</sup> and demographic variables. Again, all notation is defined in Chapter 4. Thus, if either (a)  $r_m < r$  or (b)  $r_m > r$  and  $W_t < P_{Ht}H^*$  (i.e. the value of the house purchased is greater than the wealth holdings of the household), then the amount of mortgage debt demanded by the representative household will be a function of the purchase price of the house,  $P_{Ht}$ , the optimal demand for housing,  $H^*$ , and household wealth,  $W_t$ .

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<sup>14</sup> As in Chapter 4, permanent income is proxied by current measured income (which will clearly be the most important component of permanent income) and financial wealth. Permanent income is used explicitly in a number of empirical models of mortgage demand, including Hewitt and Thom (1978), Kent (1980) and Askari (1986) among others. Nevertheless, a significant number of studies use either nominal or real current disposable income, including Huang (1966), Hall and Urwin (1989) Wilcox (1985) and Ostas and Zahn (1975). Holmes (1993) uses the wider measure of gross domestic product. The preference for including current income in the equations estimated in the following chapter is that potential homeowners tend to be constrained in their demand for mortgage finance by *measured* (and not permanent) income.



However, there are a number of additional considerations which must be taken into account when specifying the demand for housing (and thus also for mortgage debt). In particular, when formulating an empirical model we must consider the tilt problem (see Chapter 3 for a full discussion), mortgage rationing and taxation (in particular the MIRAS scheme). These issues are addressed in Section 6.4 of this chapter and further in Chapter 7.

### 6.3 GENERAL DATA SPECIFICATION ISSUES

Prior to addressing the precise nature of the variables to be included in both the mortgage demand and supply functions (see Section 6.4 below), this section deals with a number of issues regarding the general specification of the data.

#### 6.3.1 Real versus Nominal Variables

All variables included in the empirical model of the mortgage market in Chapter 7 will be specified in real as opposed to nominal terms. In this respect, we may distinguish between two types of variable : those measuring a financial quantity (such as the level of mortgages traded or total financial assets) and those which are constructed as a ratio or proportion (such as the loan to value ratio). Clearly, the latter category of variables have, through their construction, already been implicitly converted into real terms. The loan to value ratio, for example, tells us the average amount of mortgage loan granted to first time buyers *as a proportion of the value of the housing collateral*; as such, it is inappropriate to deflate any variable representing the ratio of two financial series.

On the other hand, nominal financial variables must be explicitly deflated in order that we may obtain their real (or constant price) counterparts. There exist a number of deflators published by the Office for National Statistics (ONS) which may be used to convert nominal current price series to constant prices. To maintain consistency throughout, all nominal financial variables in the empirical model presented in this thesis will be converted into constant price series using the same deflator. Given that

we are modelling the personal sector mortgage market, it is most appropriate to use the consumers' expenditure implicit price deflator. The implied deflator is calculated by dividing consumers' expenditure at current prices by consumers' expenditure at constant prices. Thus, to convert the nominal series to constant prices we simply divide the current series by the implied deflator.

### 6.3.2 Seasonal Adjustment

There is an issue as to whether seasonally adjusted or non-adjusted data should be used in the empirical analysis of Chapter 7. It is argued here for the use of seasonally adjusted data in order to avoid the complications of testing for and estimating cointegrating equations and testing for unit roots in the presence of seasonal noise. For example, when using data which is not seasonally adjusted, the standard Dickey-Fuller procedure must be modified in order to test for seasonal unit roots (see Ghysels and Perron (1993)). Sims (1974) considers the implications of undertaking estimations on a data set containing seasonally unadjusted variables by evaluating the effects of seasonal noise on parameter estimates as an errors-in-variables problem. He analyses the nature of the asymptotic biases that result from OLS estimation of lag distributions when either seasonal noise is present in the data or the seasonal adjustment process is incomplete. However, we must not lose sight of the problems which may be experienced by using seasonally adjusted data in cointegrating equations, in particular the adverse consequences for the power of the ADF and Phillips-Perron tests for cointegration (see Otero and Smith (1996) for an examination of such difficulties).

Although all of the data series required for the empirical estimation are available from the ONS databank in their raw seasonally unadjusted state, some are not provided in their seasonally adjusted form. There has, however, been a considerable empirical and theoretical literature examining the importance of consistency in using the same method of seasonal adjustment for the variable set of any single model. As Wallis (1974) shows, if all variables in a regression are adjusted according to the same filter,



the underlying relation between them will not be altered, although the error term will no longer be white noise but be a high-order moving average process.

The process of any seasonal adjustment procedure attempts to separate from the original series (denoted  $O$ ) fluctuations due to the trend and cycle,  $C$ , trading day variations (occurring as a result of calendar composition),  $TD$ , the irregular component,  $I$ , and the seasonal component,  $S$ . It is conventional to assume that these components are related to each other multiplicatively as follows

$$O = C \times TD \times S \times I \quad (6.6)$$

with the seasonally adjusted series consisting of only the trend/cyclical and irregular components ( $C \times I$ ).

This section considers briefly two methods of seasonal adjustment. The first is the simplistic dummy variable method, in which an OLS regression is undertaken of a quarterly seasonal series  $y_t$  on a constant and three seasonal dummy variables as follows

$$y_t = \alpha_1 + \alpha_2 S_2 + \alpha_3 S_3 + \alpha_4 S_4 + \varepsilon_t \quad (6.7)$$

where  $S_2$ ,  $S_3$ , and  $S_4$  represent quarterly seasonal dummy variables such that the value of  $S_i$  is unity in quarter  $i$  and zero otherwise<sup>15</sup>. The seasonally adjusted or 'deseasonalised' series is then taken to be the residuals of the above regression plus the mean of the dependent variable (to account for the inclusion of the constant in equation (6.7) which serves to 'de-mean' the resulting series), i.e.  $y_t^{SA} = \hat{\varepsilon}_t + \bar{y}_t$ .

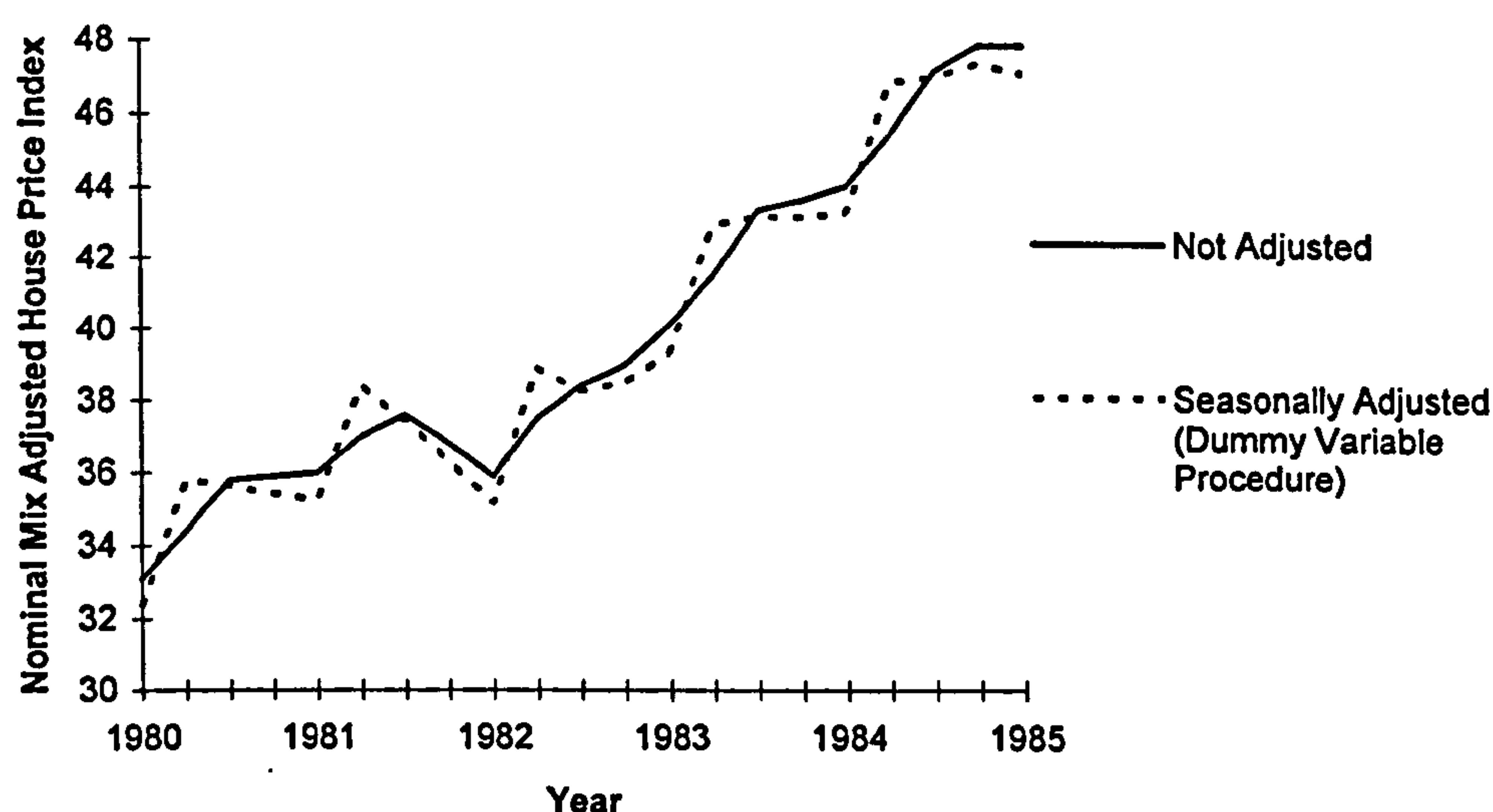
However, on using this method it was found that for a number of data series the seasonal dummies were insignificant, and also that seasonally adjusting the series in this way appeared to *induce* seasonality in some series. This was found to be most

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<sup>15</sup> We include in the regression equation only three seasonal dummy variables as the inclusion of four would lead to perfect correlation amongst the dummies (i.e.,  $S_1 + S_2 + S_3 + S_4 = 1$ ).

notable for the mix adjusted house price series in both logarithmic and level form (see Figure 6.5 below). However, seasonally adjusting the *log of the first difference* in house prices in this way resulted in a seasonally smoothed series for house price changes, with the fourth order effects in the autocorrelation function for the seasonally adjusted change in the log of house prices being eliminated.

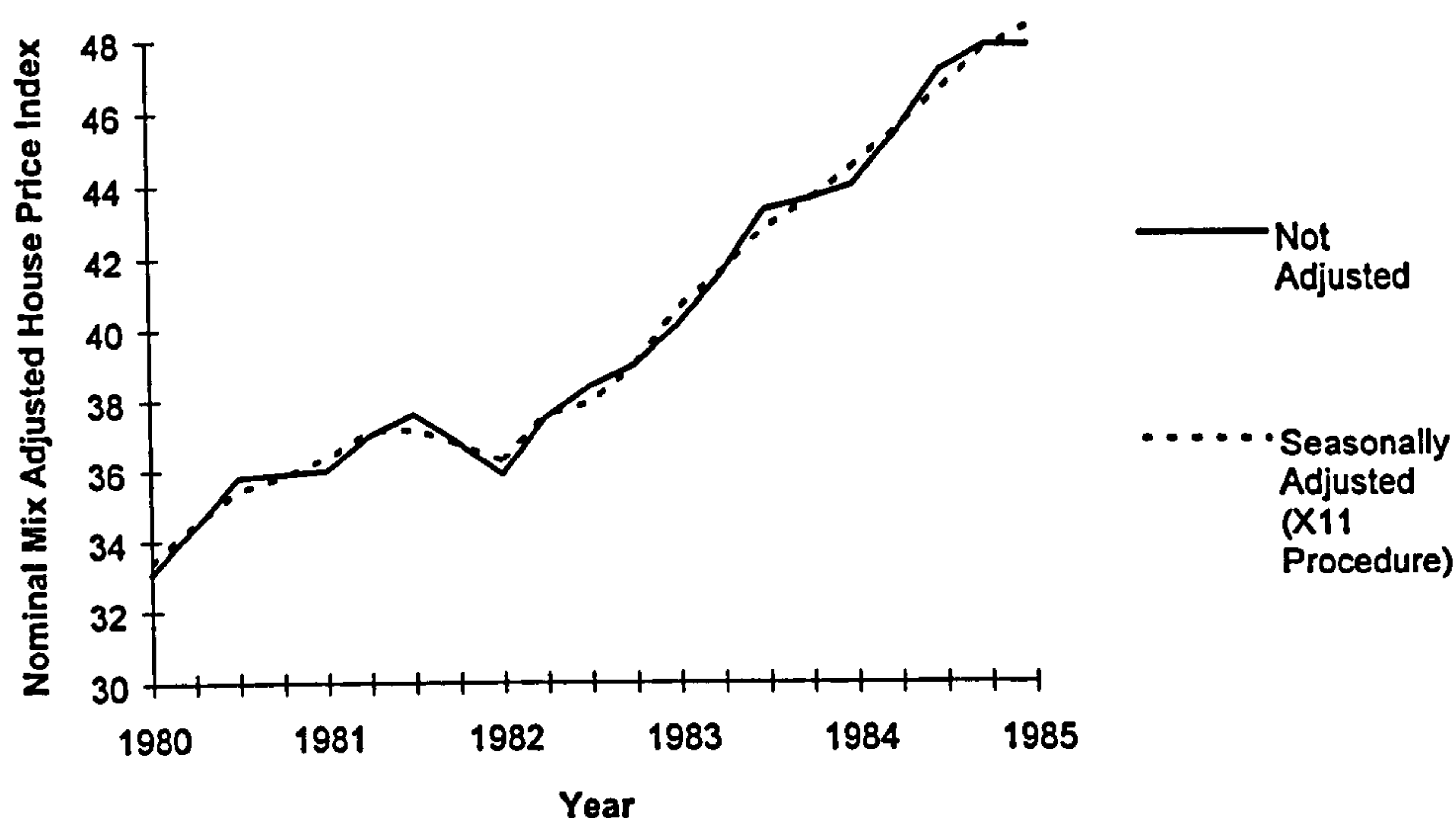
**Figure 6.5 : Seasonality in the Nominal House Price Index - Seasonal Adjustment Using the Dummy Variable Method**



The second (and by far superior) seasonal adjustment technique proposed is the X11 procedure and it is this method which is used in this thesis. It is an adaptation of a technique used by the US Census Bureau and is available as a procedure in SAS (a summary of how the procedure works is given in Appendix 6.2). Figure 6.6 below shows the same nominal mix adjusted house price series as in Figure 6.5, but this time plotted against its seasonally adjusted counterpart obtained from the X11 procedure. It can be clearly seen that in contrast to Figure 6.5, the X11 seasonal adjustment procedure has smoothed the original series and removed its seasonal component.



**Figure 6.6 : Seasonality in the Nominal House Price Index - Seasonal Adjustment  
Using the X11 Procedure in SAS**



### 6.3.3 Time Interval of the Data

Finally, quarterly data is used for all estimations, and where quarterly data is not available a quarterly series is interpolated. The cubic spline method of interpolation is the same as that used for the data of the model of arrears, possessions and house prices, and the interested reader is referred to Appendix 4.1 for a discussion. As the variables of importance in the mortgage model estimation have not as yet been discussed (see Section 6.4 below), it is sufficient to point out at this stage that interpolation from annual data was undertaken for the series representing the cost of the MIRAS scheme and the net capital stock and capital consumption of private sector dwellings. However, in using quarterly series we must be aware that building societies (and banks) have traditionally issued monthly statistics and have made decisions at monthly intervals with regard to interest rate setting. However, the lack of monthly data on a significant number of other non-interest rate variables to be included in the model binds us to using quarterly data. The quarterly data set spans from 1969Q1 to 1995Q1, with estimations undertaken on a number of subsets of the whole sample.

## 6.4 VARIABLE CHOICE AND CONSTRUCTION

In this section, the specific choice of variables intended to represent supply and demand factors in the empirical model of the mortgage market to be estimated in the following chapter is analysed. Where raw data cannot be used the method of construction of the variable is discussed. The section is split into three subsections which deal with the three endogenous variables in the system, the exogenous supply variables and finally the exogenous demand variables (again, it must be noted that the formal specification will be discussed fully in Chapter 7)<sup>16</sup>. Figures plotting all variables in their seasonally adjusted constant price form are shown in Appendix 6.1.

### 6.4.1 Variables Endogenous to the System

#### 6.4.1.1 Net Mortgage Advances (*AAPR*)

The first consideration in modelling the supply of and demand for mortgage lending is the scope of the dependent variable, i.e. whether the dependent mortgage variable should be specified as mortgage lending by building societies, banks or aggregate mortgage lending across all financial institutions.

The use of building society mortgage lending data poses a number of problems. Firstly, aggregate building society lending has in the recent past fallen substantially as a result of the conversion of a number of building societies to Plc status, a trend which may be seen clearly in Figures 6.3 and 6.4 of Section 6.1 above. Although it is possible to account for such changes by the inclusion of dummy variables the preference is to choose as parsimonious a model as possible especially due to the data intensive cointegration methodology presented in the following chapter. In addition, the reduced importance of building societies in the mortgage market suggests that we should not model their behaviour separately from that of other financial institutions.

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<sup>16</sup> The name by which each variable will be referred in the subsequent estimation chapter appears in parentheses beside the variable title in the discussions below.



Secondly, by modelling mutual financial institutions separately from other mortgage lenders, a term to capture the mortgage interest rate differential between building societies and other lenders must be included in the estimation of the demand for societies' mortgage loans<sup>17</sup>. Since banks and mortgage lenders other than building societies have only been active in the mortgage market from the early 1980s (data for banks' mortgage interest rates only commence in 1981Q1), the interest rate differential will only cover a limited time series, requiring a zero restriction on the parameter prior to this date. Moreover, augmented Dickey-Fuller (ADF) tests found the mortgage interest rate differential between banks and building societies to be stationary, precluding its inclusion in any long run cointegrating vector.

The above discussions would suggest the use of total mortgage lending across all financial institutions as the dependent variable, although we must be aware of the possibility of aggregation bias. In addition, aggregating across all financial institutions will preclude the use of the model of building society mortgage supply as derived in Chapter 5.

The ONS provide a number of series that may be used to represent aggregate mortgage lending : the total level of loans outstanding secured on dwellings, its first difference (i.e. net advances for loans secured on dwellings) or gross advances for loans secured on dwellings. With ADF tests clearly implying that total mortgage loans outstanding are integrated of order 2 and the gross advances figure only being available from 1986 onwards, the preference here is to use net mortgage advances.

#### 6.4.1.2 The Rate of Interest on Mortgages ( $r_m$ )

The choice of the appropriate mortgage rate of interest is an important consideration in the empirical specification of an aggregate model of the mortgage market. Over the periods in which the model is to be estimated, building societies have been the dominant players in the market for mortgage lending, and thus it is the rate of interest on building society mortgages that is used in the estimations of the following chapter.

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<sup>17</sup> This type of differential term provides the basis for the mortgage demand function in the model of building society interest rate setting of Chapter 5 (see Section 5.2.4.2 ,equation (5.12)).

We may dismiss the use of bank mortgage interest rates due to the limited availability of data.

There are three possible choices regarding the precise specification of this rate; we may use either the basic mortgage rate, the average rate (i.e. averaged rate across all mortgage loans of the society) or the rate of interest on new mortgages. As a means of inducement, financial institutions regularly offer discounted mortgage rates to new borrowers for the first few years of the loan, making the rate of interest on new mortgages considerably lower than that of either the basic or average rate. Assuming that mortgage borrowers (lenders) are rational, they will base their decision to take out (offer) a mortgage loan not only on the new mortgage rate but also on the basic rate which they will face in the future. Although this would suggest the use of the average mortgage rate, such data is available only over a relatively short period of time. In addition, if the average rate were used the strong assumption of a uniform distribution of borrowers in the society at each stage in the mortgage cycle (i.e. from new mortgagee to the household making its final repayment) must be made. If this were not the case, then the calculated average rate would not accurately reflect the actual average rate that the individual new mortgagee would expect to face over the lifetime of his own mortgage loan; with a boom (slump) in current new mortgage demand, for example, the average rate could be significantly downwardly (upwardly) biased. Thus the basic rate on mortgages charged by building societies (averaged across a selection of major societies) is used in the subsequent analysis.

#### 6.4.1.3 The Loan to Value Ratio (ZLVF)

The stringency of the non-interest rate credit terms of the mortgage loan contract will be influential in the determination of both the supply and demand for mortgage finance. Jan Brueckner in a number of papers has examined the relationship between the household's demand for housing and for mortgage finance. In his 1986 paper, for example, he considers the effect of the downpayment ratio on housing demand by constructing a theoretical two-period model of utility maximisation in which it is concluded that the presence of a binding downpayment constraint leads the potential



owner occupier to reduce his optimal house size, essentially trading off his initial consumption against the benefits (namely tax incentives) of future home ownership<sup>18</sup>.

Indeed this has been the general conclusion of the literature in this area, whether macroeconomic or microeconomic, empirical or theoretical; that the higher is the downpayment ratio the lower will be mortgage demand and the more likely will be mortgage demand deferral. Studies which report no effect of non-interest rate mortgage loan terms on the demand for or supply of mortgages have tended to be in the minority. For example, empirical studies by Dhrymes and Taubman (1969) on the US savings and loans industry and Silber (1968) for a variety of US financial intermediaries both find no evidence to suggest that loan terms other than the rate of interest have any independent effect on either the demand for or supply of mortgages.

The use in this thesis of the loan to value ratio (or equivalently the downpayment ratio) for first time buyers with building societies to act as a proxy for all non-interest credit terms is discussed fully in Section 7.1 of the following chapter<sup>19</sup>.

#### 6.4.2 Exogenous Supply Side Variables

##### 6.4.2.1 Ratio of Housing Collateral to Outstanding Mortgage Debt (*COLLAT*)

The inclusion in the supply function for housing finance of a ratio measuring the capital stock of personal sector dwellings relative to the total value of loans outstanding secured on dwellings is intended as a measure of risk. As Drake and Holmes (1997) suggest, the ratio would be expected to fall during a housing market slump, upon which the prospect of negative equity would increase, thus raising the probability of arrears and ultimately possessions; as such, financial intermediaries would be less willing to supply funds for mortgage lending, *ceteris paribus*. Other variables that have in the past been popular in measuring risk in the specification of

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<sup>18</sup> One drawback of the model is that Brueckner assumes (for tractability) that consumption of housing services is exogenous.

<sup>19</sup> Other potential non-interest credit terms include the average maturity of the loan, loan initiation charges and the loan to income ratio. It is the problem of collinearity between these non-interest rate credit terms that suggests the use of a single measure in the empirical model specification.

supply have included both the number of arrears and possessions as a proportion of the number of outstanding mortgages; the possessions measure has generally been favoured over that of arrears since a borrower can technically be in arrears whilst making substantial repayments to the mortgage lender.

#### 6.4.2.2 Availability of Mortgage Funds : Personal Sector Savings per Period (*AAAU*)

Given that the change in the amount of funds deposited with financial institutions is an important factor in the determination of the net amount of mortgage lending per period (the more readily available are such funds, the more elastic will be the mortgage supply curve)<sup>20</sup>, an important component of the supply specification must be a variable representative of the availability of funds in each period. Arcellus and Meltzer (1973) measure the availability of mortgage funds to on-lend by the total stock of outstanding mortgage debt, which is problematic since it will not only reflect factors which act to change the quantity of funds willing to be supplied at any particular interest rate, but also the current and previous financing decisions of home owners. More appropriate variables to capture the dependence between mortgage supply and fund availability are considered below.

- The change in total deposits held with mortgage lending financial intermediaries. This measure is adopted by both Browne (1988) and Drake and Holmes (1997) in their estimations of UK building societies' mortgage supply schedules. However, the use of this variable overlooks an important problem. Prior to the mid-1980s, the liability side of a building society's balance sheet consisted primarily of retail deposits<sup>21</sup> and the asset side was composed almost exclusively of personal mortgage lending, the result of strict lending regulations. As such, increases in building societies' mortgage loans in any quarter prior to the mid-1980s must have been accompanied by an almost one-for-one increase in their deposits during that period. To the extent that societies' funds were attained primarily in the retail

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<sup>20</sup> See Section 7.1.4 of Chapter 7 for a brief discussion of this proposition.

<sup>21</sup> Building societies only entered the wholesale deposit market in 1983 following which the Building Societies Act of 1986 laid down legislation permitting societies to access wholesale funds up to a statutory maximum of 40 per cent of their asset value (50 per cent following the Building Societies Act of 1997).



deposit market during the 1980s and early 1990s, Drake and Holmes have estimated what may be considered an accounting identity (i.e. that assets equal liabilities) rather than any behavioural relationship<sup>22</sup>.

This problem is exacerbated during periods in which mortgages are rationed. When the inflow of funds to a mortgage lending institution is included in the mortgage supply function under a regime in which mortgage lending is rationed, it alone will determine the volume of mortgages actually traded. The estimated equation will then tend to be a near identity, devoid of any behavioural interpretation (see Emran and Shilpi (1996)). As a result, the exogenous supply side variables ( $z^s$ ) may yield nonsensical parameter estimates which may be statistically insignificant. In addition, if we were able to consistently estimate the structural supply schedule, then the estimated interest rate elasticity may appear very small as there would be little variation left to be explained with the inflow of funds almost completely determining mortgage supply.

- Personal sector savings may be considered a better indicator of the ease with which a building society or bank may attract funds for the purpose of mortgage lending<sup>23</sup>. This avoids the problems of Drake and Holmes (1997) since the behavioural relationship will be extracted by using a supply variable which acts as a proxy for the *potential ease* of attaining deposits; this will influence the amount of mortgage funds that a building society is prepared to lend at any particular real mortgage rate of interest. In addition, since this thesis is focused on explaining total mortgage lending across *all* financial institutions, the use of a variable representing the

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<sup>22</sup> In their long run cointegrating model of UK building societies' nominal mortgage demand and supply, Drake and Holmes found a coefficient of 1.163 on a measure of the net inflow of nominal total shares and deposits to building societies in the supply equation. This is hardly surprising given the identity discussed in the main text. However, the restriction that this coefficient was equal to unity was rejected. A possible reason for this was that during their chosen period of estimation (1980Q2 to 1992Q4) legislation was introduced allowing societies to undertake non-mortgage lending and societies slowly began to fund their asset portfolio using a combination of retail and wholesale deposits. Given their study estimates that an increase in retail deposits by £1 would, on average, lead to an increase in mortgage supply of £1.16, the excess of £0.16 presumably would be met either by an increase in the building society's holdings of wholesale funds or a reduction in their non-mortgage lending business.

<sup>23</sup> The use of alternative variables such as the change in total personal sector financial assets in attempting to capture the potential willingness of the personal sector to save may be argued to have too broad a remit.



inflow of funds to specific institutional groups (such as that used by Drake and Holmes for building societies) would be limiting, encouraging further the use of the wider personal sector savings series.

Thus, given the arguments presented above, total personal sector savings per period is used to reflect the ease of attaining additional deposits by mortgage lenders to fund their asset business. We would expect that the higher is the level of savings, the greater the amount of mortgage funds a financial institution would be willing to on-lend as a result of the ease of availability.

#### 6.4.2.3 The Cost of Mortgage Funds ( $C_m$ )

A criticism similar to that levelled at Drake and Holmes (1997) against the use of deposit inflows as an explanatory variable for mortgage lending is provided by Muth (1986). He points out that using such a measure would, "be similar to using the purchases of leather by shoe manufacturers to explain the quantity of shoes produced. The appropriate explanatory variable for a competitive producer is the unit cost of the input used". This line of thought suggests that in addition to the use of a variable measuring the *availability* of funds to mortgage lending financial intermediaries we should also include a measure of the *opportunity cost* of these funds in the mortgage supply function.

The opportunity cost of funds must reflect the return offered on alternative uses of building society or bank funds other than for mortgage supply; as such, the three month inter-bank interest rate would be the main contender. The higher is the inter-bank rate the higher will be the cost of borrowing additional funds to on-lend as mortgages and the greater will be the return from on-lending members' deposits in the inter-bank market rather than as mortgage loans. Despite the fact that mortgage interest rates have been notoriously sticky (especially during the 1970s and early 1980s) they still tend to be highly correlated with the inter-bank rates and thus the latter cannot reasonably be included in the cointegrating relationship in its level form. As an alternative, it may appear appropriate to include in the supply function the



difference between the inter-bank rate and the mortgage rate of interest; however, this cannot be included in the cointegrating vector on the grounds that it is stationary. Therefore we have had to omit the use of any variable reflecting the mortgage lenders' cost of funds; instead it is assumed the opportunity cost of funds will be negatively related to the measure of fund availability discussed above in Section 6.4.2.2.

### 6.4.3 Exogenous Demand Side Variables<sup>24</sup>

#### 6.4.3.1 House Prices (*PAHM*)

Equation (6.4) representing the theoretical model of household demand for mortgages suggests that for any given level of wealth and housing demand, the higher the price of housing ( $P_H$ ) the greater will be the household's demand for mortgage finance. This reflects the fact that in order to purchase the same quantity of housing following a rise in the house price a greater mortgage loan will be required.

However, it is possible that higher house prices may be associated with lower housing and mortgage demand as home ownership becomes more expensive (what may be referred to as a standard 'price effect'). As such, the estimated coefficient on real house prices in the structural demand equation may be lower than expected.

A mix adjusted index of house prices is used in the empirical model as compiled by the Department of the Environment, Transport and the Regions (DETR) and published in the quarterly periodical *Housing and Construction Statistics*. The mix adjusted house price data is based on a 5 per cent sample of building society mortgages. Since the mix (type, size, location and age of dwelling) changes through time, a weighted house price series that takes account of this provides a better measure of true house

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<sup>24</sup> There are a number of other variables that one may postulate will influence the demand for housing and mortgages other than discussed in this section, including demography, permanent income, intertemporal income variability, the cost of rented housing, the level of non-mortgage consumer debt and employment mobility. However, in an effort both to adhere to the proposed theoretical model of Section 6.2.2 and to guard against over-specification, these are not included in the final estimated model presented in Chapter 7.

price movements than would an index based on a simple average price (where variations in mix are ignored).

#### 6.4.3.2 Wealth (*ALDO*)

We may postulate that wealth will have two effects on the demand for mortgage finance. Firstly, we would expect to observe the usual 'wealth effect' whereby an increase in a household's financial wealth (or discounted lifetime earnings) will lead to the purchase of higher priced or larger quantities of housing (raising  $P_H H^*$ ), in turn requiring a commensurately larger mortgage.

The second effect of wealth on mortgage demand occurs directly through its effect on the demand function for mortgages ( $M^*$ ) rather than through the demand for housing ( $H^*$ ). From equation (6.4) we can see that the level of personal wealth has an important influence on the household's decision to take on mortgage debt *irrespective of the demand for housing*. When  $r_m > r$  households will minimise their mortgage borrowing and use their personal wealth as a substitute for mortgage debt. This will act against the wealth effect described above, reducing the expected positive coefficient on wealth in the structural mortgage demand function. Alternatively, when  $r_m < r$  households will maximise their mortgage borrowing; in this case, the only influence that wealth will have on mortgage demand will be through the positive wealth effect on the underlying demand for housing. Thus, as discussed in Section 6.2.2, one would expect a higher coefficient on wealth in the mortgage demand function when estimated over the 1970s, a period in which  $r_m < r$  during a number of quarters due to the presence of high inflation and relatively static rates of mortgage interest.

In specifying the variable to represent financial wealth, it is aggregate wealth across the entire population of owner occupiers *and* non-owner occupiers that will be important in the demand for mortgage finance; existing owner occupiers and potential owner occupiers will (respectively) *adjust* and *choose* the value of their house and mortgage depending on their financial wealth (with regard to existing owner occupiers



see Jones (1993, 1995) for a discussion of costless mortgage recontracting). Thus financial wealth is represented by the total value of gross financial assets outstanding which is published quarterly in *Financial Statistics*.

In addition, it is worthwhile to point out that the parameter on the wealth variable in the model of mortgage demand may confuse the wealth effect with what may be termed a 'constraint effect'. Specifically, since the household's current wealth must be sufficient to cover the initial downpayment on the mortgage loan, the lower is the household's wealth the less able the household will be to meet the downpayment. This will force those wealth constrained households to purchase housing of a lower value and in the extreme to rent rather than purchase, both leading to a reduction in mortgage demand. In micro-econometric studies, both Haurin (1991) and Linneman and Wachter (1989) separate out the two effects; they determine whether a household is constrained by current wealth by comparing current housing demand with a measure of *desired* housing demand. The 'degree of constraint' is then taken to be the difference between the minimum downpayment on the *desired* house and current wealth. Further, Haurin finds that if a household is lacking current wealth with which to finance the downpayment on a house, then the probability that a typical 35 year old head of household will decide to become an owner occupier will fall from 0.92 to 0.37. In addition, he concludes that wealth constrained households become homeowners by, "significantly downsizing their purchased amount of housing compared to their desired house".

Finally, Follain and Dunsky (1996) argue that there is an issue as to whether wealth should be excluded from the mortgage demand function since it is an endogenous variable in their model of housing and mortgage choice (and of course also in Jones' model presented earlier in this chapter). As such, their paper presents regression results both with and without a variable measuring net worth. Wealth has, however, been used successfully in a significant number of studies of empirical housing tenure choice. For example, Jones' (1989) study based on Canadian household data concludes that accumulated *non-human* wealth (rather than *human* capital<sup>25</sup>) is the

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<sup>25</sup> The latter being derived from human wealth as the discounted sum of expected future earnings.

dominant factor in determining the stage at which a household will decide to become an owner occupier rather than a renter of housing.

#### 6.4.3.3 The Rate of Inflation (*INFL*)

The emerging literature during the 1970s and early 1980s on the demand for housing began to question the previously accepted notion that anticipated inflation should be neutral with respect to housing consumption. Indeed, general price inflation which leaves relative prices and real incomes unchanged will still have significant effects on both housing consumption and mortgage decisions for two reasons, both of which are considered below.

Firstly, the tilt effect suggests that for any constant real rate of interest, the demand for mortgage finance will be lower the higher is the rate of inflation. To restate the conclusions reached in Section 3.3.2 of Chapter 3, the demand for mortgage finance will depend not only on the real rate of mortgage interest but also on the nominal rate. The effect of inflation is to force the borrower into having to make higher real mortgage repayments in the early years of the loan, encouraging potential borrowers to either postpone or even abandon the house purchase decision. The problem is manifested in the way that monthly repayments rise disproportionately following a rise in the nominal mortgage rate of interest due to an increase in inflation. Thus even if inflation is correctly anticipated and nominal incomes adjust accordingly, the real cost of a mortgage in the early years of the loan may, depending on the type of contract, rise significantly.

Secondly, when mortgage payments are tax deductible and capital gains and imputed income from owner occupation are tax free, higher inflation will reduce the after-tax user cost of housing (assuming that nominal interest rates respond to inflation) and thereby increase mortgage demand even if inflation is anticipated and relative prices are constant.



The discussion above suggests that the rate of inflation should be included in the empirical specification of the mortgage demand function. To maintain consistency with the way in which constant price series were constructed above (see Section 6.3.1), inflation is measured as the percentage rate of increase of the implicit consumers' expenditure price deflator. Although the tilt effect would suggest the finding of a negative coefficient on the rate of inflation, the effect of inflation on the after-tax user cost measure and the desire by investors to purchase housing assets to hedge against high inflation may both act to reduce the negativity of the estimated coefficient on the rate of inflation in the mortgage demand function.

#### 6.4.3.4 Mortgage Interest Relief At Source (MIRAS)

The MIRAS scheme allows homeowners to offset a certain proportion of their mortgage interest payments against their income tax liability<sup>26</sup>. Over the past decade, the rate at which individuals may offset this interest payment has been falling. Relief could be deducted up to the higher rate of income tax until 1990/91 and at the basic rate until 1993/94, following which the rate fell to 20 per cent from 1994/95, 15 per cent from 1995/96 and 10 per cent from 1998/99. Prior to 1974/75, relief was given for the interest on the full amount of any size of loan, following which MIRAS was limited to the interest paid on £25,000 (and £30,000 from 1983/84). Before August 1988, each borrower was allowed relief up to the limit even if their loans were for the same property. Since then, the limit for new loans has been £30,000 *for each property*, irrespective of the number of borrowers. The MIRAS scheme whereby borrowers pay the mortgage lender the interest less the tax relief was introduced in April 1983 (with lenders being reimbursed for the amount deducted), prior to which interest was deducted from taxable income via assessment or through PAYE (Pay As You Earn).

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<sup>26</sup> MIRAS is given for the interest paid on loans for the purchase of a property which will be the only or main residence of the borrower. Before April 1988 it was also given for home improvement loans for the only or main residence of the borrower and loans for the purchase of a house for a dependent relative or divorced/separated spouse of the borrower.

It is assumed that mortgage demand will be a function of the total amount of MIRAS benefits<sup>27</sup> received *per pound of mortgage debt outstanding*. Specification of the MIRAS variable in this way rather than simply as the 'headline' rate of relief has two benefits. Firstly, changes in not only the rate of relief but also mortgage limits and the rules applying to the MIRAS scheme will be reflected by changes in this ratio. Clearly this is desirable given the variety of changes to the scheme as discussed above. Secondly, by dividing the total amount of MIRAS benefits by the level of outstanding mortgage debt the exogeneity of the variable is ensured. Data on the cost of MIRAS (and its forerunner the Option Mortgage Scheme<sup>28</sup>) to the exchequer are provided annually in the publication *Inland Revenue Statistics*.

It should be noted that this measure of MIRAS is included in the demand equation separately as well as being a component part of the real user cost variable. The usefulness of including the variable separately in the demand function is that it will allow us to gain an insight into the effect of the gradual reduction in MIRAS benefits on mortgage demand, which could not be provided by simply examining the coefficient on the user cost variable. Inclusion of MIRAS benefits in the composite user cost variable alone would mean that the variability in the percentage of mortgage relief paid would not completely or accurately be reflected on mortgage demand. Thus, both the real user cost and MIRAS measures are included in the estimations of the following chapter, with the coefficient on the MIRAS measure accounting for the variation in MIRAS as a proportion of mortgages *over and above* that already accounted for by the coefficient on the real user cost<sup>29</sup>. The size and significance of the individual MIRAS variable in the model will clearly have important implications for government housing finance policies.

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<sup>27</sup> Or their equivalent prior to 1983.

<sup>28</sup> The Option Mortgage Scheme applied only to homes in England, Scotland, Wales and the Isles of Scilly, but not to homes in Northern Ireland, the Channel Islands or the Isle of Man.

<sup>29</sup> It is decided not to adjust the user cost variable by deducting the MIRAS measure since this would then cause difficulties in interpreting the coefficient on the real user cost.



#### 6.4.3.5 The Real User Cost of Owner Occupied Housing ( $R(UC)$ )

It is supposed in Section 6.2.2 that the real user cost of owner occupied housing will be an important factor in the demand for housing and therefore, through equation (6.4), will also be influential on the household's demand for mortgage finance (the theoretical derivation of the user cost variable is discussed fully in Chapter 4). The empirical specification of the real user cost is as follows

$$R(UC) = \frac{\kappa - MIRAS + \mu + \delta}{\text{Value of personal sector dwellings}} + (1 - \theta)i - E_t(\dot{P}_H) \quad (6.8)$$

where the individual components are discussed fully below.

- *Property Taxes ( $\kappa$ )*

Taxes on property (denoted  $\kappa$  in the user cost equation) may be separated into two different tax rates : the amount of local property taxes paid ( $\kappa_{LP}$ ) and the amount of stamp duty paid ( $\kappa_{SD}$ ) both as a proportion of the net capital stock of personal sector dwellings<sup>30</sup>.

The most direct form of property tax in the UK currently is the Council Tax which is a tax payable to the local authority, the amount being dependent upon which of the eight valuation bands the property belongs. Local authority taxes have, however, existed in two other guises. Prior to April 1990 the tax was known as the Domestic Rates, the calculation of which being similar to that of the Council Tax. However, for the period between April 1990<sup>31</sup> and April 1993 the tax was superseded by the Community Charge which required the payment of a blanket per-capita tax of a fixed nominal amount (although varying across local authorities) *irrespective of housing tenure*

<sup>30</sup> The formulation of the taxation component of the user cost variable (both property taxes and MIRAS) as total taxation revenue as a proportion of the value of the personal sector dwelling stock alleviates the need for dummy variables to take account of such events as the abolition of double tax relief on mortgages in 1988Q4 and the suspension of stamp duty on housing during 1992 in specifying the model of mortgage finance. The dummy variable approach has been suggested by Drake and Holmes (1997).

<sup>31</sup> And from April 1989 in Scotland. In addition, the Rates system remained operative in Northern Ireland beyond 1990.

*status*. Both the Community Charge and Council Tax differ from the Domestic Rates system in terms of liability; in the former case it has been the occupant of the house (whether owner occupier or renter) who has tended to pay the tax whereas in the latter case it has generally been the owner<sup>32</sup>. This provides a justification for the exclusion of both the Community Charge and Council Tax from the local property tax series in the real user cost since they do not represent the *additional* cost faced from ownership of the property. However, given that the Council Tax increases with the value of the property, the presence of the tax will reduce the demand (in terms of housing value) for both rental and owner occupied housing<sup>33</sup>. In the case of owner occupation, this will have the effect of lowering the demand for mortgage finance and hence the Council Tax should indeed remain in the property tax component of the user cost.

The Community Charge on the other hand is not at all related to the housing tenure decision. Thus, in order that we may keep the Community Charge component in the property tax series (thus preventing a large structural break in the series) we make the simplifying assumption that the Community Charge was expected by households to be only a short term measure; as such, households would not have made any long term housing tenure decisions on the basis of the introduction of the short term tax<sup>34</sup>.

The total amount of Community Charge and Council Tax received by local authorities per quarter are available from the publication *Financial Statistics*, whereas the Domestic Rates series was provided directly by the ONS. All of the data are measured net of rebates and on an accrued basis, thus recording local authority receipts when they fall rather than when they are paid.

Stamp duty is paid on the conveyance and transfer of land, buildings and property, with the tax rate and threshold level varying considerably over the last forty years (see Table 6.1 below). At present, the threshold under which no stamp duty is paid is

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<sup>32</sup> Although owners of rented property often passed on Domestic Rates to their tenants in the form of higher rents.

<sup>33</sup> The tax would not, however, cause there to be a substitution from one type of tenure to another since both tenures will be affected by the tax identically. It would merely reduce the demand for any particular type of tenure.

<sup>34</sup> This assumption is reasonable given the considerable lack of public support for the tax.



£60,000; for transactions of over £60,000, £250,000 and £500,000 a duty of 1, 1.5 and 2 per cent respectively is levied on *the whole* of the transaction price. Total stamp duty receipts received by the Inland Revenue are available quarterly from the publication *Financial Statistics*<sup>35</sup>. One may expect to see clustering of housing demand just under the stamp duty thresholds due to the sudden leap in the marginal stamp duty paid once the threshold is exceeded.

**Table 6.1 : Rates of Stamp Duty on Conveyances and Transfers of Land, Buildings and Property other than Stocks and Shares**<sup>36</sup>

Commencing date	Threshold and rates of duty				
	Nil Rate	0.5%	1%	1.5%	2%
	Considerations up to	Considerations exceeding			
	£	£	£	£	£
1 Aug 1958	3,500	3,500	4,500	5,250	6,000
1 Aug 1963	4,500	4,500	6,000	-	-
1 Aug 1967	5,500	5,500	7,000	-	-
1 Aug 1972	10,000	10,000	15,000	-	-
1 May 1974*	15,000	15,000	20,000	25,000	30,000
6 Apr 1980	20,000	20,000	25,000	30,000	35,000
22 Mar 1982	25,000	25,000	30,000	30,000	40,000
13 Mar 1984	30,000	-	30,000	-	-
20 Dec 1991	250,000	-	250,000	-	-
20 Aug 1992	30,000	-	30,000	-	-
16 Mar 1993	60,000	-	60,000	-	-
8 July 1997	60,000	-	60,000	250,000	500,000

\* Northern Ireland 1 August 1974

- *Mortgage Interest Relief At Source (MIRAS)*

The implicit rate of mortgage interest tax relief appears negatively in the formulation of the user cost variable, with a rise in the rate of relief leading to a fall in the cost of owner occupation. For inclusion in the user cost formulation this variable is specified as the total amount of MIRAS benefits received per pound of owner occupied dwelling stock (rather than as a percentage of the mortgage stock) since the real user

<sup>35</sup> Due to industrial action, stamp duty figures for the second to fourth quarters of 1981 are unavailable. We do know, however, that the total figure for the three quarters as a whole is £591m. The missing data are then interpolated using the cubic spline technique, the total amount for the three quarters being constrained to be £591m. The resulting data is £184m, £202m and £205m for the three quarters respectively.

<sup>36</sup> This table is reproduced from Inland Revenue Statistics 1998.

cost relates to the percentage cost of servicing one pound of owner occupied housing rather than one pound of mortgage borrowing. For more information on the MIRAS scheme the interested reader is referred back to Section 6.4.3.4.

- *Insurance, Repairs and Maintenance Costs ( $\mu$ )*

It is likely that the ratio of insurance, repairs and maintenance costs to the value of the personal sector dwelling stock are not intertemporally constant; rather, increases in the quality of construction over time may have reduced the real costs of housing repairs and upkeep. In construction of the variable  $\mu$  as a component of the user cost measure we use consumers' expenditure at market prices on housing maintenance by owner occupiers, which includes contractors charges and structural insurance.

- *The Rate of Depreciation of the Housing Asset ( $\delta$ )*

We must account for housing depreciation in the real user cost of owner occupied housing since theoretically, the amount by which the property depreciates over the length of holding period will mean an equivalent reduction in the final sale price of the asset over and above that of the general rate of house price inflation (thus increasing the user cost of housing capital). The data series used to reflect depreciation in the construction of the real user cost of housing is that of total capital consumption on personal sector dwellings, measured at current replacement cost published annually in the ONS *Blue Book*.

- *The After-Tax Savings Rate ( $(1 - \theta)i$ )*

The after-tax national savings rate is included in the formulation of the user cost as a measure of the opportunity cost of the funds tied up in the housing asset.



- *Expected Future House Price Changes ( $E_t(\dot{P}_H)$ )*

The real user cost variable defined by equation (4.5) in Section 4.2.1 of Chapter 4 includes a measure of anticipated future house price appreciation. The inclusion of expected house price appreciation will account to some extent for the investment component of the demand for owner occupied housing; as such, a higher expected increase in the future price of housing will act as an inducement to purchase (through its reduction of the user cost of housing capital) and stimulate a greater amount of mortgage borrowing. As is noted by Hamnett (1994), although the ability to invest may be restricted to certain specific groups, “the exchange value of housing is now a major consideration in house purchase decisions”. However, in contrast to the discussion above, the theoretical model of Fu (1995) suggests that a greater expected house price appreciation, or lesser uncertainty as to the future price of housing, need not induce housing investment (unlike the theoretical results of Henderson and Ioannides (1983)<sup>37</sup>).

Kent (1980, 1981) empirically models the expected future percentage change in house prices,  $E_t(\Delta P_H / P_H)$ , to be included in the user cost measure as a weighted function of current and past percentage changes in house prices as follows

$$E_t(\Delta P_H / P_H)_t = \sum_{i=0}^n (1-\lambda)\lambda^i (\Delta P_H / P_H)_{t-i} \quad (6.9)$$

In both papers, Kent found that the best results were obtained by using  $i = 9$  and  $\lambda = 0.975$ . Modelling expected future house price appreciation using equation (6.9) is, however, largely *ad hoc* and unsatisfactory. A superior way of modelling the expected percentage change in house prices would be to make in-sample forecasts using an autoregressive moving average model, or ARMA( $p,q$ ); given that the percentage change in nominal house prices (as measured by the change in the log of

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<sup>37</sup> As is discussed in their paper, “renting becomes more attractive if housing is subject to random capital gains or losses”.

the nominal mix adjusted house price index) is stationary<sup>38</sup> the estimated ARMA model is equivalent to estimating an ARIMA( $p, d, q$ ) on the log of the nominal house price series where  $d = 1$ . The specification of the parameters of the ARMA, namely the number of autoregressive terms ( $p$ ) and the number of moving average terms ( $q$ ) depends on the nature of the data and the process that we expect is generating the series. The approach taken to ARMA model selection is based on the Box-Jenkins (1976) three stage procedure for identification, estimation and diagnostic checking. The first stage, identification, involves a visual examination of plots of the time series itself, the autocorrelation function and the partial autocorrelation function. The identification stage leads to the suggestion of a number of possible tentative specifications which may be considered more fully on estimation.

The sample autocorrelation with lag  $k$  (denoted  $\hat{\rho}_k$ ) of a variable  $y_t$  is simply the covariance between  $y_t$  and  $y_{t+k}$  ( $\gamma_k$ ) divided by the variance of  $y_t$  ( $\gamma_0$ ), or

$$\hat{\rho}_k = \frac{\sum_{t=1}^{T-k} (y_t - \bar{y})(y_{t+k} - \bar{y})}{\sum_{t=1}^T (y_t - \bar{y})^2} = \frac{\gamma_k}{\gamma_0} \quad (6.10)$$

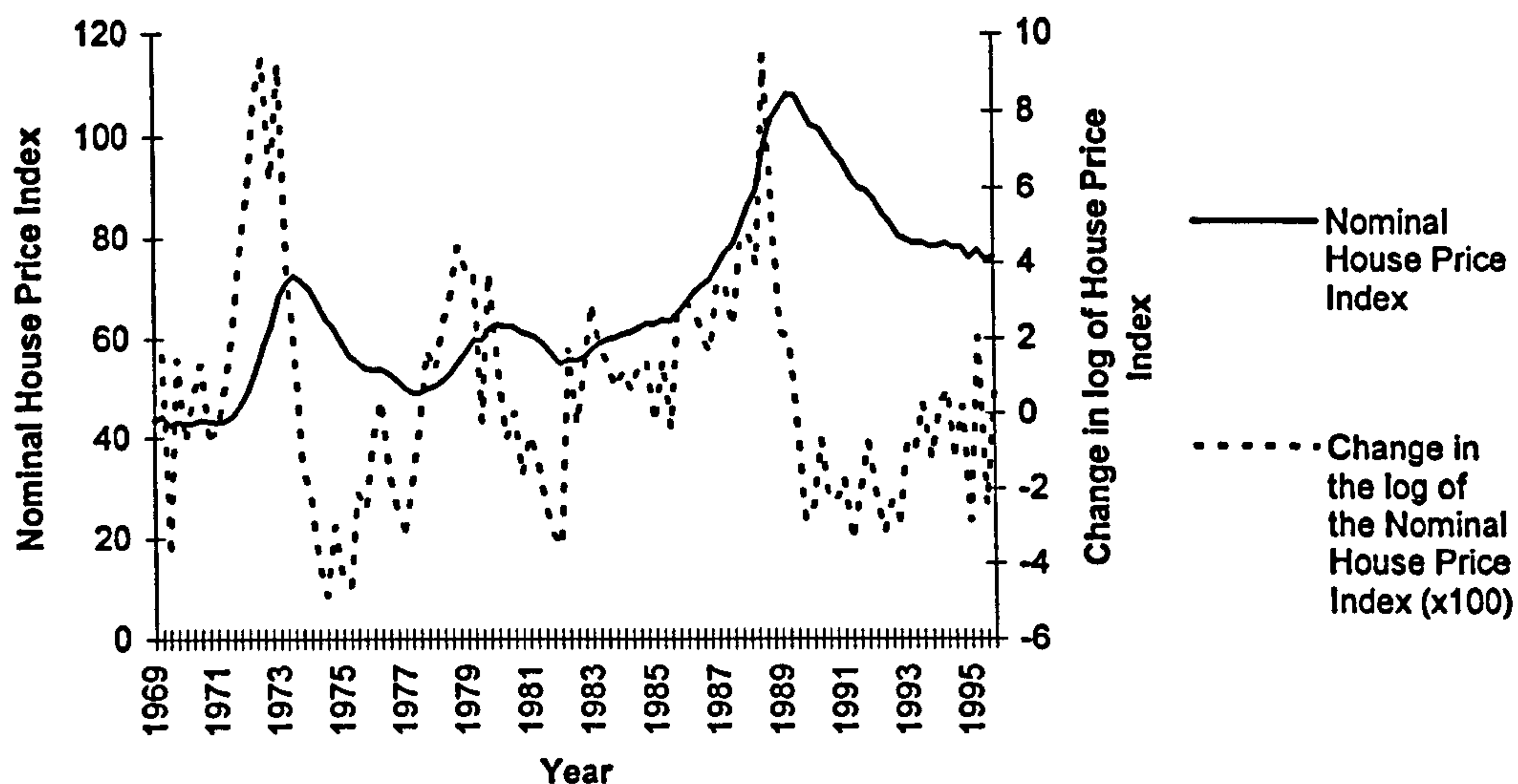
and the autocorrelation function is shown by plotting  $\hat{\rho}_k$  on the vertical axis against  $k$  on the horizontal axis. For a stationary time series one would expect to see the function falling rapidly to zero for successively larger values of  $k$ , and for a non-stationary series to tail off only gradually. Figure 6.7 below shows a time series plot of the mix adjusted nominal house price index and the first difference of its logarithm, Figure 6.8 the autocorrelation function for the first difference in log of the house price index and Figure 6.9 the partial autocorrelation function for the log difference series.

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<sup>38</sup> This can be confirmed by graphing the series itself, checking its autocorrelation function or performing augmented Dickey-Fuller tests with appropriately chosen lags.



**Figure 6.7 :** The Seasonally Adjusted Nominal Mix Adjusted House Price Index and the First Difference of its Logarithm ( $\Delta \ln P_{Ht} = \ln P_{Ht} - \ln P_{Ht-1}$ )<sup>39</sup>



In considering the autocorrelation function and the partial autocorrelation function for the change in the log of the nominal house price series, it is important to take into consideration any seasonality that may be present in the data. The presence of seasonality in a data series will influence the autocorrelation plot; in the case of the house price series, a plot of the autocorrelation function for the seasonally *unadjusted* change in the log series revealed important fourth order peaks and troughs, suggesting that it contained a strong seasonal element.

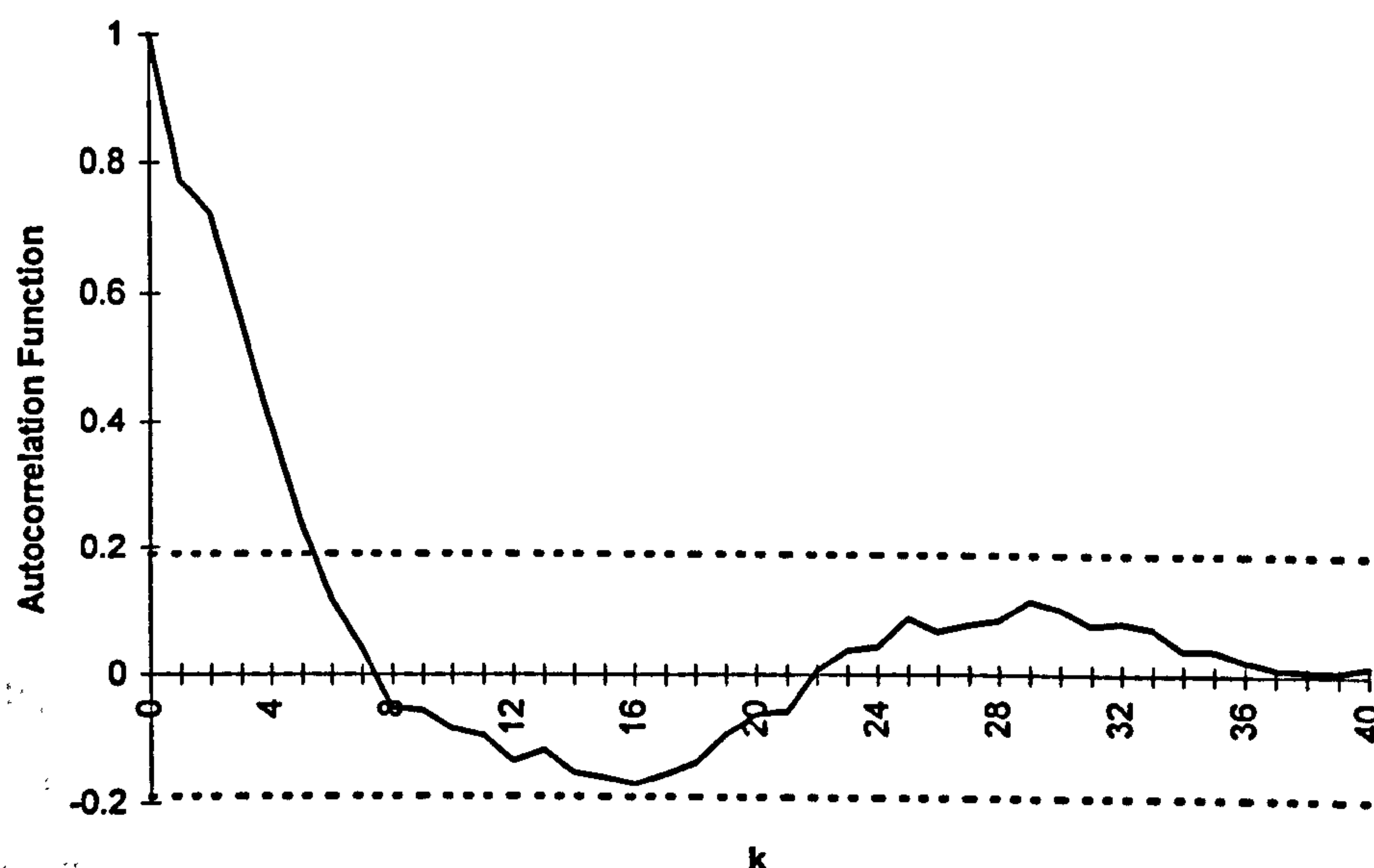
It is quite clear from Figure 6.8 below that the autocorrelation function suggests that the first difference of the log level series is stationary since the function tails off towards zero very rapidly as the number of lags is increased<sup>40</sup>. In addition, it is useful to point out that the majority of the quarterly peaks and troughs that were present in the seasonally unadjusted series are no longer present in the adjusted series. Thus the

<sup>39</sup> The actual series modelled in the ARMA procedure below is that of  $\Delta \ln(P_{Ht+1}) = \ln P_{Ht+1} - \ln P_{Ht}$  (denoted  $\dot{P}_{Ht}$  in the remainder of the chapter) since it is the expected *future* proportionate change in house prices that is important. Note that all references to house price changes in this section are quarterly.

<sup>40</sup> The results from examining the second difference in the series and its autocorrelation function do not seem qualitatively different from those of the first difference; it is thus concluded that differencing once should be sufficient to ensure stationarity.

process of deseasonalisation has enabled us to distinguish between those spikes in the autocorrelation function indicative of the presence of moving average terms and those representing seasonal variations.

**Figure 6.8 : Autocorrelation Function for the First Difference in the log of the Seasonally Adjusted Nominal Mix Adjusted House Price Index**



It is important to test the joint hypothesis that all (or a group of) values of the autocorrelation function (for  $k > 0$ ) are zero; if this were the case, it would imply that the underlying series (i.e. the first difference in nominal house prices) is white noise. This would clearly be undesirable given that we require to use the series to predict its future value. To undertake such a test requires the use of Box and Pierce's (1970)  $Q$ -statistic. Box and Pierce show for a sample size of  $T$  that

$$Q_1 = T \sum_{k=1}^K \hat{\rho}_k^2 \sim \chi^2(K) \quad (6.11)$$

under the null hypothesis of no significant autocorrelations. If the calculated value of  $Q_1$  exceeds the appropriate critical value, we must conclude that at least one autocorrelation is non-zero.



Ljung and Box (1978) report that a problem with the Box-Pierce  $Q$ -statistic is that it works poorly even in reasonably large samples. The Ljung-Box modification is a superior small sample test and is defined below as

$$Q_2 = T(T+2) \sum_{k=1}^K \hat{\rho}_k^2 / (T-k) \sim \chi^2(K) \quad (6.12)$$

Thus if the calculated  $Q$ -statistic is greater than the critical Chi-square distribution with  $K$  degrees of freedom at the 5 per cent level of significance (the level of significance is often taken to be 10 per cent in such tests) we can be 95 per cent (or 90 per cent in the case of 10 per cent significance) confident that the true autocorrelation coefficients,  $\rho_1 \dots \rho_K$  are *not* all zero (i.e. at least one value of  $\rho_k$  is statistically different from zero at the specified level of significance)<sup>41</sup>. With the number of observations for the first difference in the log of the nominal house price index totalling 111, the  $Q$ -statistic is found to be (for the first 25, 20, 15 and 10 lags respectively) 217.68, 215.60, 204.60 and 193.35 for  $Q_2$  and 206.56, 204.95, 195.82 and 186.11 for  $Q_1$ , all of which exceed the critical values of the Chi-square distribution at the 95 per cent level (37.65, 31.41, 25.00 and 18.31 respectively). Thus one may conclude that the autocorrelation function is significantly non-zero along its length and thus is not a white noise process (it is therefore predictable).

In addition, and perhaps of more use, we may use a well known rule of thumb to test whether any particular value of the sample autocorrelation coefficient,  $\hat{\rho}_k$ , is close enough to zero in order to permit the assumption that the true value of the autocorrelation coefficient,  $\rho_k$ , is indeed zero. Since all of the autocorrelation coefficients (for  $k > 0$ ) are approximately normally distributed with a mean of zero and variance of  $1/\sqrt{T}$  (see Bartlett (1946)), it is possible to check whether any coefficient is statistically significant at the 5 per cent level, say, by observing if it

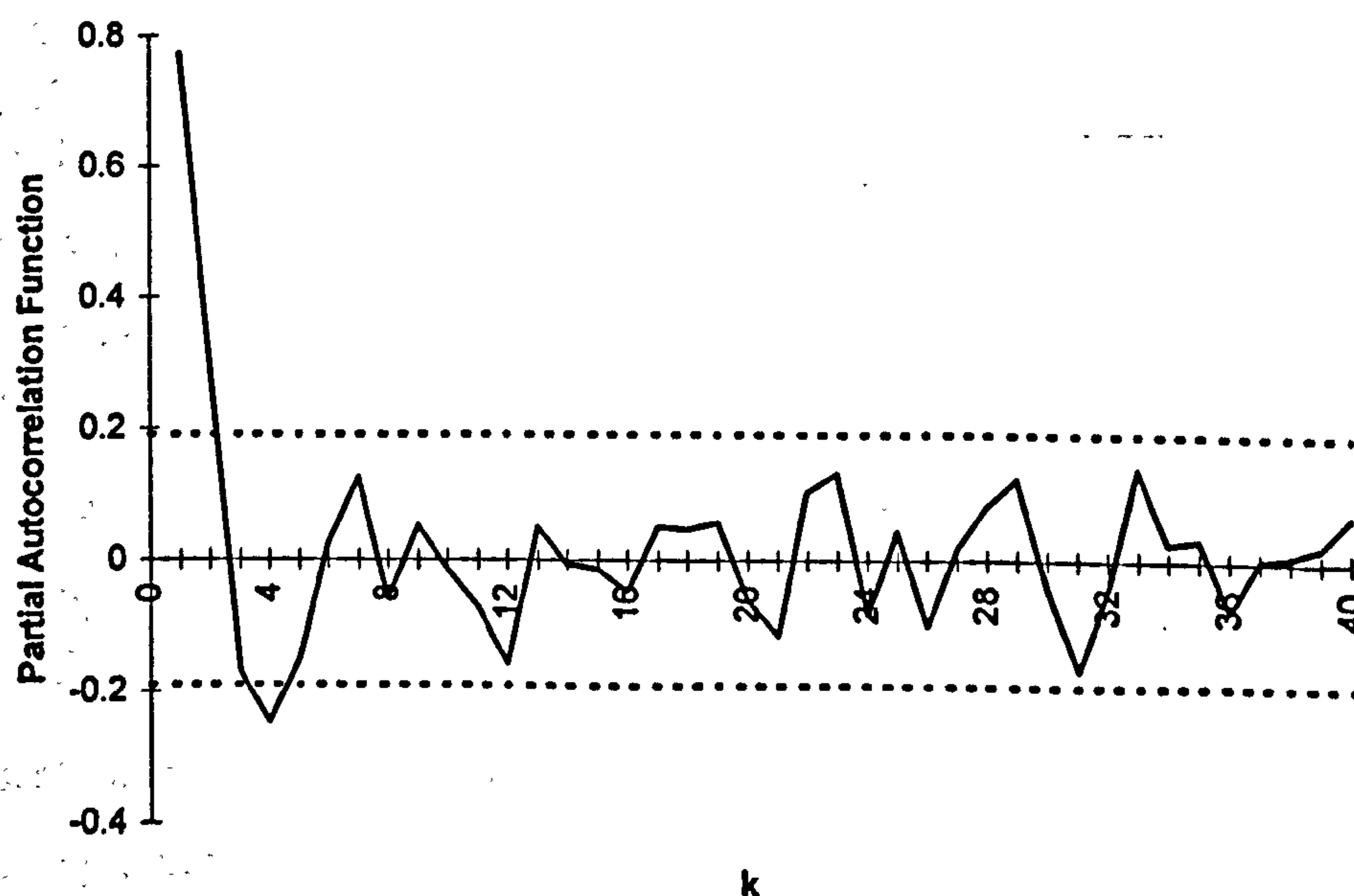
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<sup>41</sup> The calculation of both  $Q$ -statistics requires the assumption of stationarity.

exceeds  $1.96/\sqrt{T}$  in magnitude (thus the dotted lines in Figures 6.8 and 6.9 represent the 95 per cent confidence limits)<sup>42</sup>.

Although we may be able to make an informed guess as to the specification of the number of moving average terms to include in the model by consideration of the autocorrelation function, the specification of the number of autoregressive components of the ARMA process is, however, more difficult if the decision were to be based on the original data and the autocorrelation function alone; the partial autocorrelation function yields more information in determining the number of autoregressive terms, and as such is presented below in Figure 6.9. The partial autocorrelation function of  $y_t$  and  $y_{t-k}$  is simply the least squares regression coefficient on  $y_{t-k}$  in a regression of  $y_t$  on a constant and  $k$  lagged values of  $y_t$ . This is computed for  $K = 40$  lags and shows the correlation of  $y_t$  and  $y_{t-k}$  after removing the influence of the intervening lags.

**Figure 6.9 : Partial Autocorrelation Function for the Change in the log of the Seasonally Adjusted Nominal Mix Adjusted House Price Index**



<sup>42</sup> With 111 observations on the change in the log of the nominal mix adjusted house price index, the critical values become  $\pm 0.1860$ .



The order of the autoregressive process may be inferred from the above figure; if the true order of the process is  $p$ , then we should observe all partial autocorrelation coefficients,  $a_j$ , to be zero for  $j > p$  and non-zero for  $j \leq p$ . Again, since all of the coefficients are approximately normally distributed with a mean of zero and variance of  $1/\sqrt{T}$ , any particular coefficient is statistically significant at the 5 per cent level if it exceeds  $1.96/\sqrt{T}$  in magnitude (again represented by the inclusion of the dotted lines in Figure 6.9). Ignoring the slightly large partial autocorrelation coefficient at lag 4, examination of the partial autocorrelation function would suggest an autoregressive component of  $p = 2$ .

In choosing the most appropriate ARMA model, it is also informative to consider the summary statistics for a number of alternatively specified models; these are presented in Table 6.2 below for ARMA models with parameters  $p$  and  $q$  from 0 to 5. This is the estimation stage of the Box-Jenkins procedure, with the parameters of the model being estimated using the econometric package Shazam. A brief discussion is in order regarding the routines used by Shazam to estimate the ARMA model. Whereas a pure autoregressive model may be estimated by OLS, the inclusion of moving average terms requires the use of a non-linear estimation method (Shazam uses Marquardt's algorithm (1963)). The second column of Table 6.2 represents the number of iterations of the non-linear algorithm before model convergence is achieved. Obviously, a lack of speedy convergence in the non-linear search procedure would imply the possibility of parameter instability (i.e. adding only a few observations to the series may greatly affect the coefficients).

The  $R^2$  statistic of column 6 must be interpreted with care since the 'fit' will necessarily improve the more parameters that are included. Adding further moving average or autoregressive lags requires the estimation of more coefficients with a loss of degrees of freedom. The inclusion of unnecessary coefficients will also reduce the forecasting ability of the model.

**Table 6.2 : Summary Statistics for ARMA Models of the Change in the log of Seasonally Adjusted House Prices<sup>43</sup>**

Specification	No. Iter.	AIC	SC	No. $t > 1.96$	$R^2$	Adjusted $R^2$
ARMA(0,1)	13	1.6714	1.7202	1/1	0.3569	0.3510
ARMA(0,2)	13	1.4053	1.4785	2/2	0.5182	0.5093
ARMA(0,3)	15	1.1738	1.2715	3/3	0.6245	0.6140
ARMA(0,4)	152	1.1530	1.2750	4/4	0.6441	0.6307
ARMA(0,5)	33	1.1297	1.2762	5/5	0.6633	0.6473
ARMA(1,0)	11	1.1919	1.2408	1/1	0.6016	0.5979
ARMA(1,1)	13	1.1588	1.2320	2/2	0.6251	0.6181
ARMA(1,2)	14	1.0516	1.1493	3/3	0.6715	0.6622
ARMA(1,3)	16	1.0641	1.1862	3/4	0.6765	0.6643
ARMA(1,4)	22	1.0865	1.2330	2/5	0.6785	0.6632
ARMA(1,5)	22	1.1105	1.2813	2/6	0.6798	0.6613
ARMA(2,0)	12	1.1186	1.1918	2/2	0.6399	0.6332
ARMA(2,1)	12	1.1349	1.2326	1/3	0.6438	0.6338
ARMA(2,2)	17	1.0531	1.1751	4/4	0.6807	0.6687
ARMA(2,3)	22	1.0724	1.2189	3/5	0.6817	0.6666
ARMA(2,4)	17	1.0982	1.2690	3/6	0.6826	0.6643
ARMA(2,5)	200+	1.1251	1.3204	6/7	0.6835	0.6619
ARMA(3,0)	12	1.1174	1.2150	2/3	0.6498	0.6399
ARMA(3,1)	13	1.0928	1.2149	3/4	0.6676	0.6551
ARMA(3,2)	15	1.0778	1.2242	3/5	0.6816	0.6665
ARMA(3,3)	13	1.1054	1.2763	0/6	0.6816	0.6633
ARMA(3,4)	19	1.1096	1.3049	3/7	0.6882	0.6671
ARMA(3,5)	58	1.1126	1.3323	6/8	0.6945	0.6706
ARMA(4,0)	12	1.0728	1.1949	3/4	0.6739	0.6616
ARMA(4,1)	12	1.0912	1.2377	1/5	0.6771	0.6617
ARMA(4,2)	20	1.1050	1.2758	2/6	0.6817	0.6633
ARMA(4,3)	14	1.1057	1.3010	2/7	0.6894	0.6683
ARMA(4,4)	17	1.1218	1.3415	4/8	0.6927	0.6685
ARMA(4,5)	17	1.1129	1.3570	9/9	0.7028	0.6763
ARMA(5,0)	12	1.0846	1.2310	2/5	0.6792	0.6639
ARMA(5,1)	12	1.1112	1.2820	0/6	0.6794	0.6609
ARMA(5,2)	30	1.1325	1.3278	1/7	0.6818	0.6602
ARMA(5,3)	21	1.0797	1.2994	6/8	0.7003	0.6767
ARMA(5,4)	19	1.1185	1.3626	8/9	0.6992	0.6724
ARMA(5,5)	39	1.1100	1.3785	6/10	0.7097	0.6806

The Akaike Information Criterion (AIC) and Schwartz Criterion (SC) are more appropriate and popular measures of fit in evaluating ARMA models since they take into consideration the Box-Jenkins requirement that the model be parsimonious.

<sup>43</sup> All models for which summary statistics are presented were found to be invertible and the AR components less than unity implying a stationary model. Invertibility is a requirement of the Box-Jenkins approach and implies that the series can be represented by a finite-order or convergent autoregressive process. This turns out to be important since use of the autocorrelation function and the partial autocorrelation function implicitly assumes the sequence may be well approximated by an autoregressive model.



They are calculated as

$$AIC = \ln(\hat{\sigma}_k^2) + 2(p + q + 1) / T \quad (6.13)$$

and

$$SC = \ln(\hat{\sigma}_k^2) + (p + q + 1) \ln(T) / T \quad (6.14)$$

where  $T$  is the sample size and  $\hat{\sigma}_k^2$  is the residual variation from the particular estimated model. Ideally we require AIC and SC to be as small as possible. In each, increasing the number of regressors increases the term  $(p + q + 1)$  but will decrease the residual sum of squares. Thus if a regressor has no explanatory power, adding it to the model causes AIC and SC to increase. Also, since  $\ln(T) > 2$ , SC will select a more parsimonious model than AIC; as Enders (1995) notes, “the marginal cost of adding regressors is greater with the [SC] than the AIC”. The SC has more desirable large sample properties; it is asymptotically consistent whereas AIC is biased towards suggesting an over-parameterised model.

To aid the choice of a parsimonious model, Table 6.2 also reports the proportion of  $t$ -statistics on the autoregressive and moving average coefficients that are greater (in absolute value) than 1.96 (i.e. significant at the 5 per cent level)<sup>44</sup>.

From a combination of the summary statistics of Table 6.2 above, the autocorrelation function and the partial autocorrelation function, the ARMA(2,2) model is chosen to represent the process determining the change in the log of nominal house prices. The predictions given by the ARMA model are used to construct a series of the expected future percentage change in house prices (as required in the construction of the user cost). The ARMA(1,2) model is rejected despite exhibiting the lowest overall AIC and SC figures since the partial autocorrelation function suggests that we should use a model with at least a second order autoregressive component. The ARMA(2,2) model has the second smallest values for AIC and SC and a higher adjusted  $R$ -squared than the ARMA(1,2).

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<sup>44</sup> Note that the calculation of  $t$ -statistics requires that the original data series be stationary.

The estimated relationship is given by

$$\dot{P}_{Ht} = 0.38 + 1.33 \dot{P}_{Ht-1} - 0.49 \dot{P}_{Ht-2} + \varepsilon_t + 0.81 \varepsilon_{t-1} - 0.55 \varepsilon_{t-2} \quad (6.15)$$

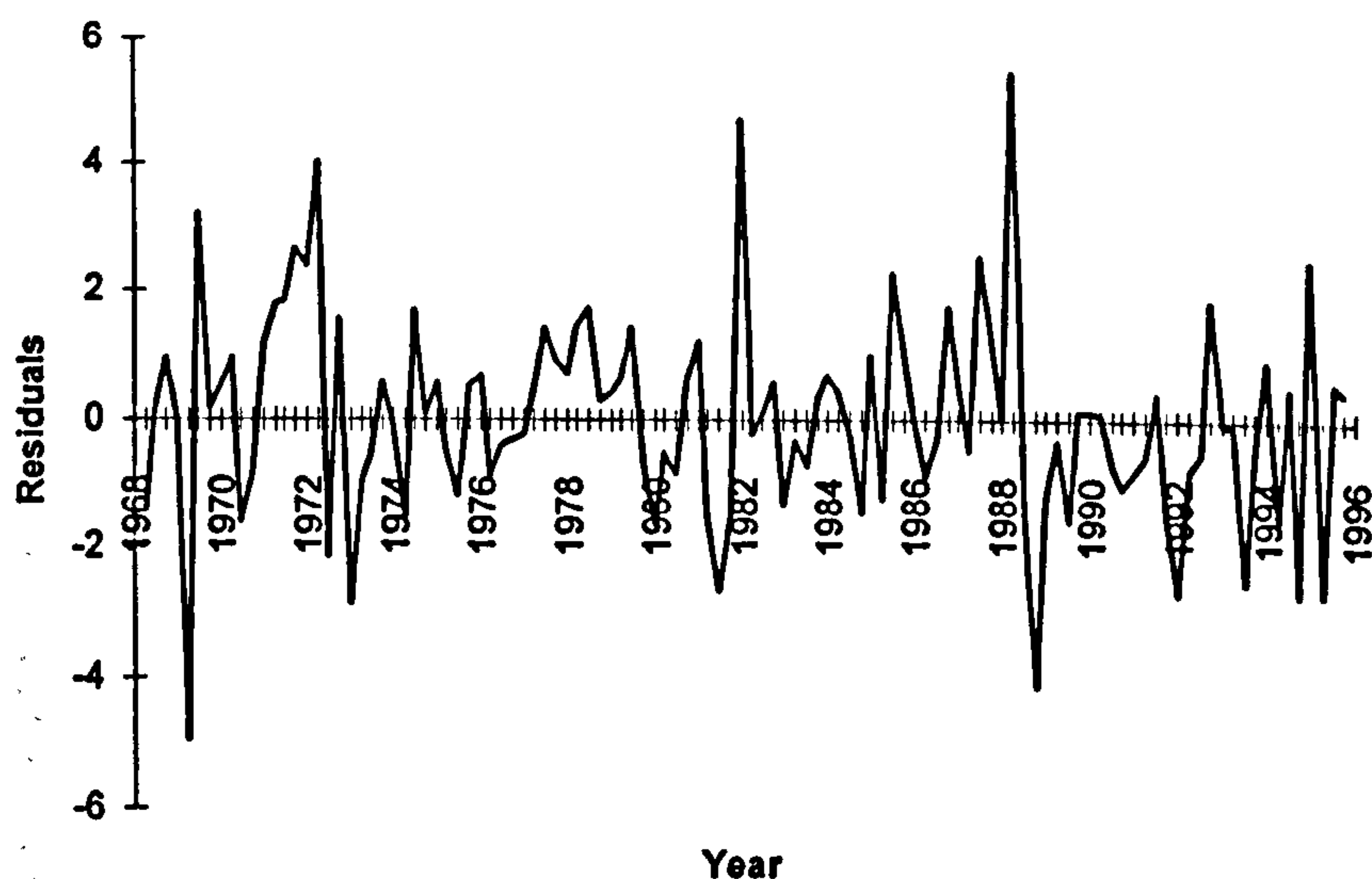
(2.39)    (7.03)                      (-2.78)                      (4.82)                      (-5.94)

where  $\dot{P}_{Ht} = \ln P_{Ht+1} - \ln P_{Ht}$  and  $t$ -statistics are shown in parentheses. Thus the fitted series may be constructed as follows

$$E_t(\dot{P}_{Ht}) = \hat{\dot{P}}_{Ht} = 0.38 + 1.33 \hat{\dot{P}}_{Ht-1} - 0.49 \hat{\dot{P}}_{Ht-2} + 0.81 \hat{\varepsilon}_{t-1} - 0.55 \hat{\varepsilon}_{t-2} \quad (6.16)$$

In the diagnostic checking stage of the Box-Jenkins approach, plots of the residuals and predicted values from the above estimation are shown in Figures 6.10 and 6.11 below.

**Figure 6.10 : Residual Plot for ARMA(2,2) Model**

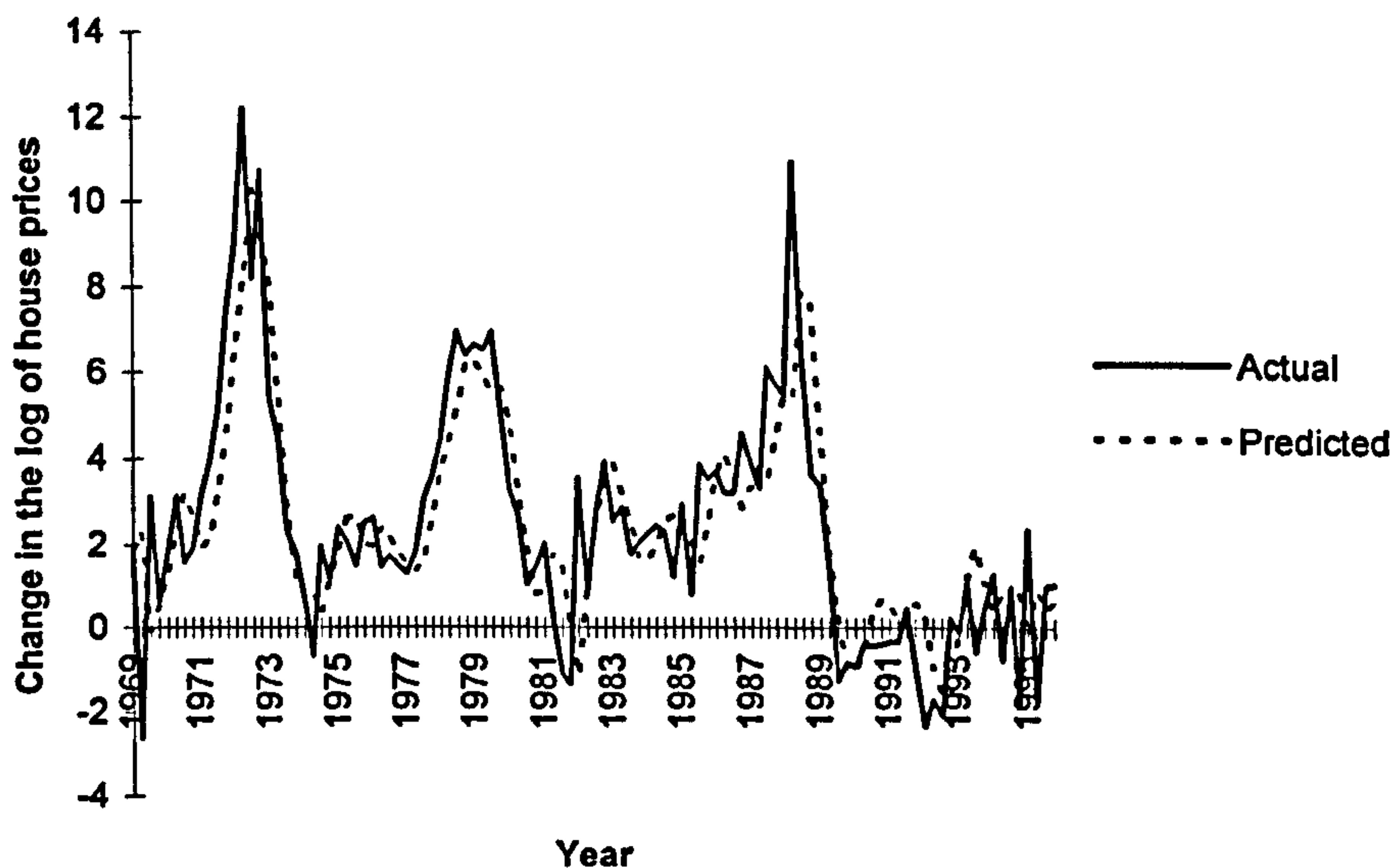


There appears (graphically at least) to be little difference in the residuals of the ARMA(2,2) model than of any other model. It is important from a forecasting perspective that there should be no serial correlation between the residuals, since this would imply the presence of a systematic movement not accounted for by the ARMA

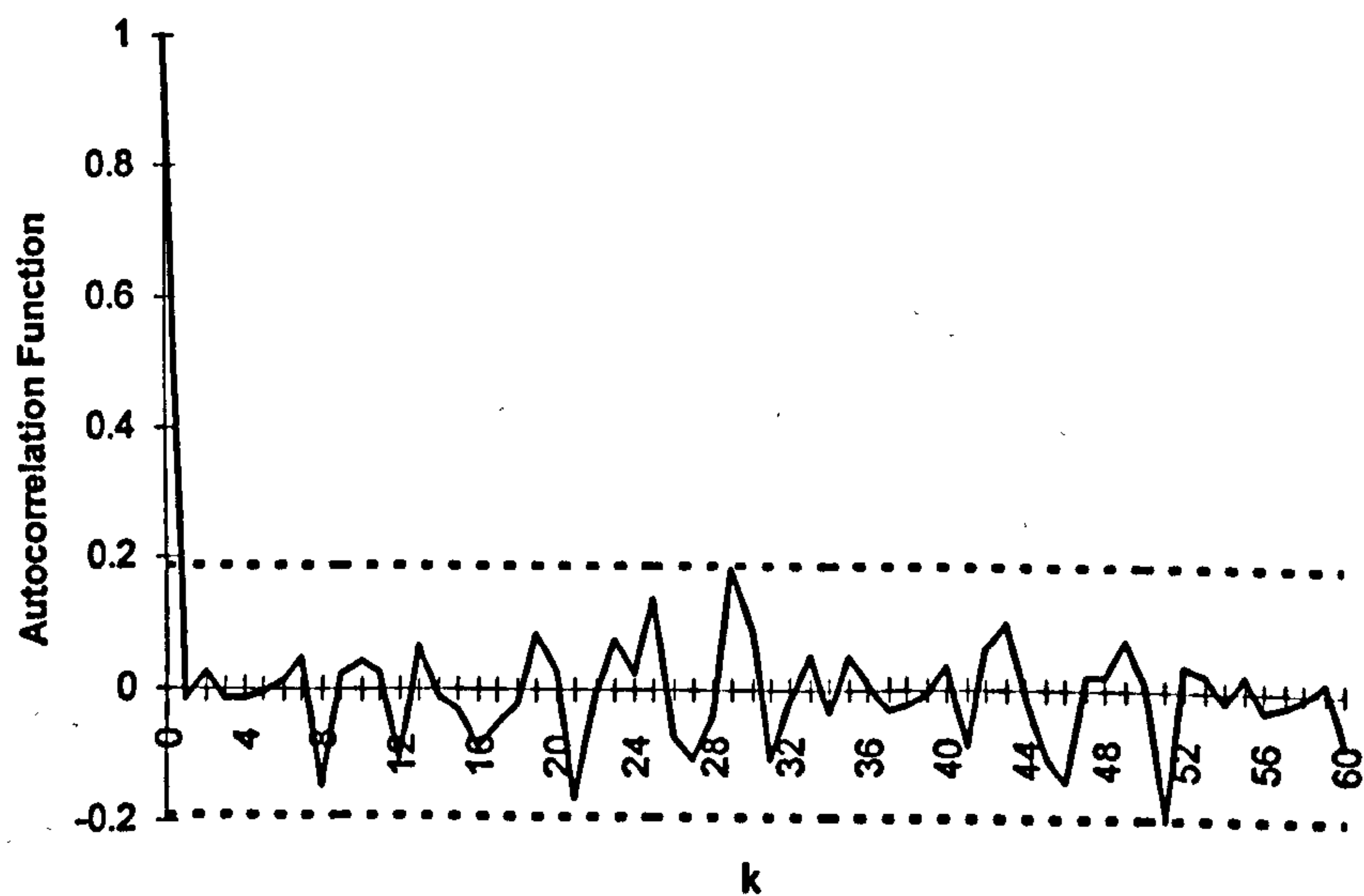


model. We can check for serial correlation in the residuals by constructing their autocorrelation function, which is presented in Figure 6.12 below.

**Figure 6.11 :** Plot of Predicted Series for ARMA(2,2) Model ( $E_t(\dot{P}_{Ht})$ )



**Figure 6.12 :** Autocorrelation Function for the Residuals of the ARMA(2,2) Model



The residual series appears to resemble a white noise process since its sample autocorrelation function  $\hat{\rho}_k$  is close to zero for all  $k > 0$ . To determine whether this

is indeed the case, both  $Q$ -statistics are calculated for the first 10, 15, 20 and 25 lags and are presented in Table 6.3 below.

**Table 6.3 : Box-Pierce and Ljung-Box  $Q$ -statistics for  $k = 10, 15, 20, 25$ <sup>45</sup>**

$k$	10	15	20	25
$Q_1$	2.99	4.84	7.03	12.79
$Q_2$	3.35	5.69	8.72	16.81
$\chi^2(k)$	18.31	25.00	31.41	37.65

It can be seen clearly from Table 6.3 that the null hypothesis of a white noise error cannot (by a wide margin) be rejected, indicating that the residuals are not serially correlated. This may also be confirmed by conducting a Wald test for the joint significance of the lagged residuals in the following OLS regression.

$$\hat{u}_t = \beta_0 + \beta_1 \hat{P}_{Ht-1} + \beta_2 \hat{P}_{Ht-2} + \alpha_1 \hat{u}_{t-1} + \alpha_2 \hat{u}_{t-2} + \alpha_3 \hat{u}_{t-3} + \alpha_4 \hat{u}_{t-4} \quad (6.17)$$

where  $\hat{u}_t$  is the residual series from the ARMA(2,2) model. Under the null hypothesis that  $\hat{\alpha}_1 = \hat{\alpha}_2 = \hat{\alpha}_3 = \hat{\alpha}_4 = 0$  the Wald statistic follows a chi squared distribution with 4 degrees of freedom. For the above test, the calculated Wald statistic turns out to be 0.797, which is well below the critical value of 9.49 implying that we may not reject the null hypothesis that the residuals of the ARMA model are not serially correlated.

As a final check on the applicability of the ARMA model fitted to the data, the same ARMA(2,2) is fitted to two subsamples containing the first 55 and the last 56 observations. This provides useful information regarding the assumption that the data generation process is stable over the entire period. The two regressions estimated are

$$\dot{P}_{Ht} = \delta_1 + \phi_{11} \dot{P}_{Ht-1} + \phi_{21} \dot{P}_{Ht-2} + \varepsilon_{1t} + \theta_{11} \varepsilon_{t-1} + \theta_{21} \varepsilon_{t-2} \quad (6.18)$$

for  $t = 1, \dots, m$  and

$$\dot{P}_{Ht} = \delta_2 + \phi_{12} \dot{P}_{Ht-1} + \phi_{22} \dot{P}_{Ht-2} + \varepsilon_{2t} + \theta_{12} \varepsilon_{t-1} + \theta_{22} \varepsilon_{t-2} \quad (6.19)$$

for  $t = m+1, \dots, T$

<sup>45</sup> Chi-square critical values are for the 5 per cent level of significance.



where  $T$  is the total number of observations in the two subsamples, with  $m$  observations in the first and  $(T-m)$  in the second. Denoting  $SSR$  as the sum of squared residuals over the whole period of estimation, and subscripted by 1 or 2 to denote the first and second periods, we may test the restriction of coefficient equality (i.e.  $\phi_{11} = \phi_{12}, \phi_{21} = \phi_{22}$  etc.) using the  $F$ -test

$$F = \frac{(SSR - SSR_1 - SSR_2) / n}{(SSR_1 + SSR_2) / (T - 2n)} \sim F(n, T - 2n) \quad (6.20)$$

where  $n$  is the number of parameters estimated (which with a constant equals  $p + q + 1$ ). Calculating  $F$  we have

$$F = \frac{(278.09 - 127.67 - 129.69) / 5}{(127.67 + 129.69) / (111 - 10)} = 1.627 \quad (6.21)$$

This is smaller than the critical value of  $F$  at the 5 per cent level with (5,101) degrees of freedom (which is 2.31) suggesting that we cannot reject the null hypothesis of equal coefficients.

Although we will use the predictions from this ARMA model of future expected house price changes as the house price appreciation component of the user cost variable, it is interesting to note that a number of authors have suggested the use of other variables which may also capture the investment motive for holding real estate.

For example, given that the purchase of housing is frequently looked upon as a hedge against inflation, a number of studies propose the difference between the change in the mix adjusted house price index and the change in the home ownership component of the retail prices index as a measure of the investment potential of home ownership. If the former is greater than the latter, then owner occupied housing has proved an effective hedge against inflation and the demand for mortgages should rise. As is noted by Rothenburg (1983), house price inflation can exceed general price inflation for a number of reasons. Firstly, "demographic trends and industrial sector changes

may suggest more stringent demand and supply pressure in this sector ... than for average industrial sectors” and secondly, “the combination of physical durability of the asset and solidity of trends making for strong future excess demands may give prospective investors the perception of housing investment as safer than any other kinds of investment”.

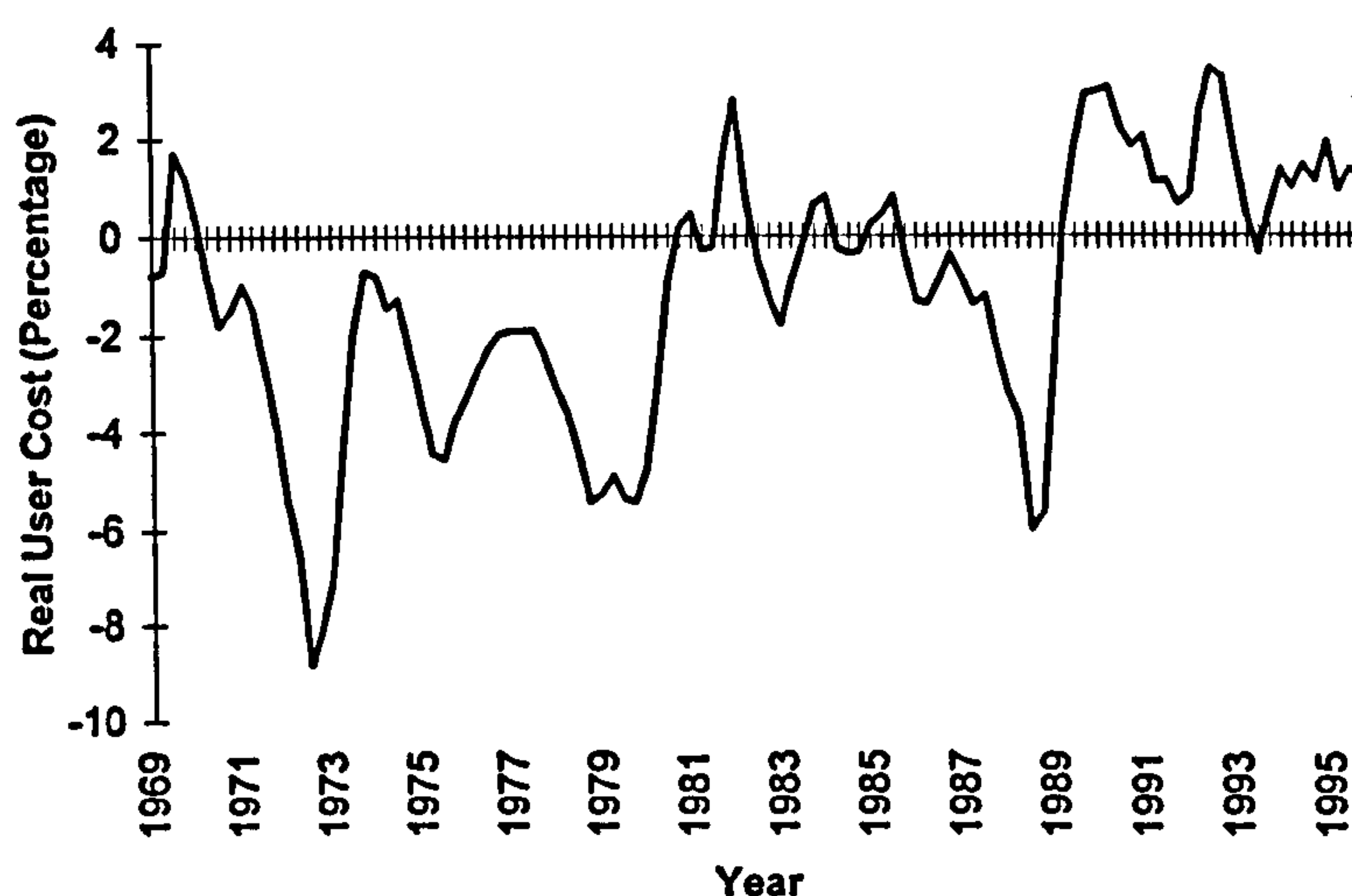
Finally, Ioannides (1989) argues that, “the relationship of housing assets with other, especially financial, assets must in some sense reflect households’ hedging needs”. In this respect, an alternative formulation of the variable intended to represent the hedging motive for home ownership is the appreciation of the house price with respect to the appreciation of financial assets. A measure of the increase in the value of financial assets may be the appreciation of the stock market (as recorded by a FTSE index) or indeed the rate of interest available on deposit or share accounts with financial institutions. Essentially, the variable must capture how effective housing is at increasing its value in contrast to alternative financial assets.

We have now considered all of the variables which make up the empirical specification of the real user cost of housing capital, and we may now look briefly at how the constructed series varies over time (see Figure 6.13 below). The negativity of the real user cost variable for a substantial portion of the estimation period means that it will be included in the regressions of the subsequent chapter in levels rather than in logarithms. This negativity is caused by large and positive anticipated future house price changes, which would suggest positive financial benefits to those purchasing and holding owner occupied housing during these periods.

The rapid boom and subsequent fall in the housing market in the late 1980s can be seen clearly, with the real user cost reaching a localised minimum in 1988Q3 and a global peak in 1992Q3.



Figure 6.13 : The Real User Cost of Owner Occupied Housing<sup>46</sup>



## 6.5 TESTING FOR A UNIT ROOT IN THE DATA

This Section presents a brief analysis of the time series properties of the data described in the previous Section to ensure that the variables included in the cointegrating relationships of the subsequent chapter are all non-stationary of order  $I(1)$ . As in Chapter 4, each variable is tested for the presence of a unit root by running an Augmented Dickey Fuller (ADF) OLS regression, as described fully in Section 4.3.3.1 of Chapter 4. Tests are conducted for the null hypothesis  $H_0 : \gamma = 0$  (implying the existence of a unit root) in equation (4.23), which is given by the  $t$ -ratio on the coefficient of  $y_{t-1}$ . Details of the results of these tests are given in Appendix 6.3.

The tables presented in Appendix 6.3 show the Akaike Information Criterion, the Schwartz criterion and the Hannan-Quinn criterion all of which may be used to determine the optimal lag length ( $k^*$ ) for the dependent variable in the ADF specification of equation (4.23); again, the interested reader is referred back to Chapter 4. In addition, the results of an LM test for lag length are presented in the appendix which is also described fully in Section 4.3.3.1.

<sup>46</sup> The real user cost is specified as a percentage of the real house price.

ADF results are reported in the tables of Appendix 6.3 for the whole data sample period (1969Q1 to 1995Q4) and the two mutually exclusive subsample periods. For each sample period ADF  $t$ -statistics are calculated for the variables discussed in this chapter and also for their first differences in order to test for integration of order 2 or higher (a methodology similar to that proposed by Dickey and Pantula (1987)).

The Dickey-Fuller procedure discussed above requires strong assumptions to be made regarding the errors of the equation (namely that they are independent and have constant variance). The methodology of Phillips and Perron (1988) is a generalisation of the Dickey-Fuller technique which does not make such restrictive assumptions; in this case, the disturbance term ( $u_t$ ) may be weakly dependent and heterogeneously distributed (the only requirement made is that  $E(u_t)=0$ ). The Phillips-Perron (PP) tests are thus modified Dickey-Fuller  $t$ -statistics after accounting for the heterogeneity in the error term. Their method is to use a non-parametric correction for serial correlation rather than including lag terms to allow for serial correlation as suggested by Dickey and Fuller.

As with the previous Dickey-Fuller procedure, the Phillips-Perron tests are performed on the regression model with both a constant and time trend included and also with a constant and without a time trend. Although the results are not reported in the appendix, a summary of the main findings is discussed.

As a summary of the findings of Appendix 6.3, both ADF and PP  $t$ - and  $F$ -tests suggest that the majority of the variables under consideration are integrated of order 1 for all three sample periods. However, the formal tests *tentatively* suggest that during both subsample periods the housing collateral series ( $\ln COLLAT$ ) and real house prices ( $\ln R(PAHM)$ ) are both integrated of order 2. Nevertheless, this conclusion is overturned by an examination of the graphical evidence (see Figures A6.3.1 and A6.3.2 in Appendix 6.3)<sup>47</sup>.

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<sup>47</sup> If indeed it was the case that house price inflation was non-stationary, this may invalidate the standard errors of the ARMA model above. However, on the basis of graphical evidence of the original series and the autocorrelation and partial autocorrelation functions, we are confident that this is not the case.



## 6.6 SUMMARY AND CONCLUSIONS

Based on an analysis of the results emerging from the theoretical mortgage supply and demand models presented in the previous two chapters, this chapter has provided an investigation into the most appropriate data series for use in the subsequent empirical model of the mortgage market. The precise specification and construction of the relevant variables has been examined, including the use of the full Box-Jenkins (1976) framework in determining an appropriate forecasting model for expected future house prices; although this model was designed in order to construct a series reflecting the expected appreciation of house prices to be used as a component part of the user cost variable, it may also be viewed as a stand-alone model in its own right.

Not only have the individual data series been scrutinised, but additionally a number of general issues regarding the specification of the data have been considered, including a discussion of the most appropriate method of seasonal adjustment of the data set. Finally, each seasonally adjusted variable is subjected to rigorous tests for stationarity from which it is concluded that all variables are integrated of order 1 and thus can be included in the cointegrating models specified and estimated in the following chapter.

## CHAPTER 7

### The Estimation of a Long Run Cointegrating Model of the Supply of and Demand for Mortgage Finance in the United Kingdom

#### 7.1 A PRELIMINARY TO THE ESTIMATION

Before discussing cointegration tests on the variables in the long run model of mortgage demand and supply, it will be useful to consider a number of specification issues.

One of the main problems which must be addressed is the way in which we should account for rationing in the mortgage market. As noted by Stiglitz and Weiss (1981), "the usual result of economic theorising : that prices clear markets, is model specific and is not a general property of markets - unemployment and credit rationing are not phantasms". A number of studies (for example Meen (1989, 1990b)) estimate that mortgage rationing in the UK ended in the early 1980s. The identification problem posed by the existence of mortgage rationing (see later in the section for a fuller discussion) has been circumvented in a number of ways in the past. Peterson and Kidwell (1983), for example, in their empirical analysis of US credit unions remove the need to account for credit rationing by estimating a reduced form model. One particular drawback with this approach is that demand and supply elasticity estimates cannot be deduced from the empirical results. In fact, the model hypothesised by Peterson and Kidwell is not truly a reduced form since it includes endogenous variables such as the rate of mortgage interest in the estimated equation for the equilibrium quantity of mortgages traded.

Paisley (1994) also avoids the problem of mortgage rationing by estimating her profit maximising model of building society interest rate setting on data post 1984 to avoid the period in which societies' interest rates were non-market clearing. An additional complication encountered in the estimation of an interest rate equation is that due to the nature of the Building Societies Association rate setting procedure prior to the



early 1980s (interest rates tended to be sticky; see Chapter 2 for a discussion), rates of interest would have to be treated as limited dependent variables, again conveniently avoided by the appropriate choice of estimation period in Paisley's study. Hewitt and Thom (1979) circumvent the rationing issue by approaching the market for mortgages from the supply side. Their study essentially neglects mortgage demand and all the problems of identification that are associated with the demand schedule.

Meen (1990a) in his theoretical model of house prices notes that in the presence of mortgage market constraints, the real user cost of housing capital may be higher than that given by equation (4.5) in Chapter 4. The denominator of equation (4.8) of the same chapter shows the effect of capital constraints (mortgage rationing) on the user cost equation; the real user cost is raised by an amount equal to the ratio of the shadow price of the rationing constraint to the marginal utility of the composite good<sup>1</sup>. As noted in Chapter 4, the derivation of equation (4.8) assumes that the constraint is represented by a limit on the total volume of borrowing rather than limits to the loan to value and loan to income ratios. Dougherty and Van Order (1982) and Ermisch (1984) show that rationing in the latter case can be accounted for by substituting a weighted average of the interest rate on financial assets and mortgage lending for the interest rate  $i$  in equation (4.5). The inability to measure  $\lambda$  or  $u_c$  in equation (4.8) means that it will be impossible to empirically account for mortgage rationing on the demand for mortgage loans in this way. In Meen's empirical investigation of real house price determination, the extent of mortgage rationing is measured by  $(\Delta \ln M_t^d - \Delta \ln M_t^s)$ , where in rationed periods  $\Delta \ln M_t^s$  equals the actual percentage increase in mortgage advances, and in unrationed periods excess demand equals zero.

Microeconometric studies of the market for mortgage funds can more explicitly account for the occurrence of mortgage rationing as many cross sectional databases contain information that may identify whether or not (and indeed the extent to which) any particular borrower is credit constrained (such information ranges from the answers to direct questions to the use of proxy variables). Follain and Dunskey (1996), for example, use the Tobit procedure to estimate their empirical specification of

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<sup>1</sup> It is also shown that the presence of rationing can distort the effect of inflation on real house prices.



mortgage demand (based on a theoretical model of household utility maximisation) for three different groups of borrower : those who are liquidity constrained, those for which the liquidity constraint is not binding and the whole sample. Although it is confirmed that the demand for mortgage debt is influenced by the nature of the credit constraints and the degree to which they bind, Follain and Dunskey point out that their empirical model is best applied to those households that are not constrained.

Sections 7.1.1 through 7.1.4 below discuss in depth the problem of mortgage rationing and how differing degrees of severity of rationing may or may not be accounted for in the mortgage supply, demand and reduced form equations.

### 7.1.1 Mortgage Rationing : Some Definitions

It is clear at this stage we must define exactly what is meant by mortgage rationing. This thesis adopts definitions of rationing which are consistent with those given in Kent (1980) and subsequently by a host of other papers including Nellis and Thom (1983) and more recently Drake and Holmes (1997). There is said to exist a *competitive market* if the adjustment of the mortgage rate of interest is sufficient to equate the desired demand for and desired supply of mortgages, whereas in a *rationed* market the interest rate does not always adjust to this market clearing or equilibrium level. In the latter case, for any given mortgage interest rate it falls upon the adjustment of other non-interest terms to allocate available mortgage funds.

We may distinguish between two types of mortgage rationing essentially depending upon the severity of the methods used to ration funds. *Equilibrium* rationing is defined as where the adjustment of a vector of non-interest rate terms of the mortgage loan contract (such as the loan to value ratio and the loan to income ratio<sup>2</sup>) is

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<sup>2</sup> If we were to incorporate all possible non-price equilibrium rationing terms in the subsequent estimations it would lead to severe problems of multicollinearity. Thus, only one non-interest term is used and must be seen as representative of all other equilibrium rationing terms. Lenders may wish to ration mortgages according to the loan to income ratio during periods of high (in absolute terms) mortgage rates in order to minimise the front-loading problem. In addition, mortgage lenders will be concerned with the borrower's ability to finance the periodic mortgage payments; in periods of interest rate rises, gross repayments will tend to rise disproportionately with respect to income, making the loan to income ratio the preferred choice. However, despite these arguments, the loan to value ratio is probably the better measure of equilibrium non-interest mortgage rationing since the definition of



sufficient to clear the mortgage market given that the rate of mortgage interest is not by itself equilibrating. On the other hand, where the adjustment of these non-interest terms is still insufficient to clear the market, lenders must engage in *disequilibrium* rationing which occurs in the form of mortgage queues or rationing according to savings records with a particular financial institution<sup>3</sup>.

### 7.1.2 Mortgage Rationing in Reality

When it is stated that mortgage rationing was ended in the early 1980s we are referring to the concept of disequilibrium mortgage rationing. We can safely assume that there *always* exists equilibrium rationing in the mortgage market if only for reasons of financial prudence on the part of the mortgage lender<sup>4</sup>. For example, there exists an upper limit on both the loan to value and loan to income ratios despite the fact that mortgage lenders have become considerably more competitive over the past two decades (and thus could possibly satisfy all mortgage demand at the going rate of interest alone by acquiring additional readily available funds)<sup>5</sup>. In fact in the second quarter of 1997 the average amount of mortgage loan a first time borrower could expect to receive was 91.2 per cent of the value of the house purchased, the highest

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borrower income has changed considerably both over time and between societies, making the use of the loan to income ratio somewhat inconsistent. The loan to value ratio is calculated for first time buyers rather than existing owner occupiers since in the presence of house price inflation, it will be difficult to distinguish between a fall in the loan to value ratio for existing owner occupiers as a result of increased rationing or due to the desire by existing owner occupiers to hold capital gains in the form of housing equity. Thus, it is the loan to value ratio for *first time buyers* that is the most appropriate proxy for equilibrium rationing as rationing measures can be applied more effectively to those who do not have the proceeds of a house sale at their disposal.

<sup>3</sup> It is important to note that other authors have used the same terminology in referring to different types of rationing. For example, Ostad and Zahn (1975) refer to equilibrium rationing as the case in which the adjustment of the mortgage rate is sufficient to clear the market, and disequilibrium rationing as where the adjustment of non-interest terms is required to clear the market when the actual mortgage rate differs from its equilibrium level. On the flip side of the coin, Nellis and Thom (1983) refer to the definitions of equilibrium and disequilibrium rationing as set out in the main text as 'market clearing' and 'non-market clearing' rationing respectively, and likewise Pratt (1980) refers to the terms as 'passive' and 'active' rationing.

<sup>4</sup> As is noted by Kent (1980), "non-price terms such as the loan to value ratio and maturity are always used by lenders in the home mortgage market to allocate funds, but during periods in which there are substantial shifts in the demand and/or supply curves, there is a qualitative shift in the use of these terms to allocate funds". A similar point is developed by Nellis and Thom (1983), who state that, "when mortgage demand has been relatively slack in the UK, borrower's income has not been the binding constraint, but rather that mortgagors have set their own limits on the level of borrowing in the interests of prudence".

<sup>5</sup> As we saw in Chapter 2, this increase in competition has been the result of the structural and legislative changes in the mortgage market over the 1980s and 1990s.



proportion since records began (although this has since fallen). In effect what the lender is trying to do by setting a maximum loan to value ratio is to reduce the problem of moral hazard. In this case, the average first time borrower must make an 8.8 per cent downpayment on the house which acts as a disincentive to a borrower taking on mortgage debt which they may find difficult to repay. The disincentive of defaulting on a mortgage loan when the downpayment required by the lender is zero is far lower than if the borrower has some of their own capital tied up in the property. As noted by Buckingham (1990), when prices are falling those borrowers with 100 per cent mortgages may find themselves with negative equity and are likely to, "struggle less hard to keep up with payments and retain their houses than those who have made a substantial equity commitment". In addition, the presence of a loan to value ratio of less than 100 per cent serves to lessen the problems of asymmetric information and adverse selection, as the ability of the borrower to meet the downpayment will act as a screening device indicating to the lender the probability of future default.

The main point which emerges from the discussion above is that the rationing of mortgages via the use of the non-interest terms of the loan is not simply a temporary short run phenomenon which disappears when interest rates adjust to their competitive equilibrium levels. Rather, non-interest rate credit rationing represents a permanent and equilibrium response by mortgage lenders for the reasons outlined above. It may be the case that changes in interest rates and non-interest rate loan terms move together to reinforce each other in rationing mortgage credit (the 'multiple term' hypothesis - see Guttentag (1960)) or alternatively that such terms are considered substitutes for one another (these propositions are examined in more detail in Section 7.1.4).

Building Societies prior to the mid-1980s operated a policy of setting mortgage interest rates below their market clearing levels, reflecting their long-held attitudes that mortgagors should be protected as far as possible from fluctuations in market interest rates and that owner occupation be promoted by keeping the cost of borrowing down. In addition, the administrative costs involved in changing borrowing rates often meant that societies were reluctant to change the mortgage rate even when



market conditions implied a change was necessary. The resulting swings in competitiveness of societies' assets and liabilities were initially absorbed by the use of the liquidity ratio as a stabilising buffer, which in some cases deferred the need to ration funds.

### 7.1.3 Empirically Accounting for Mortgage Rationing : The Demand Curve

The method of accounting for the presence of rationing on the demand side of the mortgage market depends critically upon the type of rationing that is observed.

#### *Equilibrium Mortgage Rationing*

Traditionally, mortgage demand ( $M^d$ ) has been specified as a function of the after-tax rate of interest on mortgage loans ( $r_m$ ) and a vector of independent demand-side variables ( $z^d$ )

$$M^d = d(r_m, z^d) \quad (7.1)$$

and mortgage supply ( $M^s$ ) equivalently as

$$M^s = s(r_m, z^s) \quad (7.2)$$

where ( $z^s$ ) is a vector of independent supply-side variables.

The main problem that exists in the modelling of the market for mortgages in this way is that when lenders use terms other than the interest rate to ration funds, observations may not fall simultaneously on the mortgage demand and supply curves (i.e. there exists an identification problem). With equilibrium rationing, however, the remedy is straightforward. Rather than specifying mortgage demand as a function solely of the mortgage rate of interest and a vector of independent variables, we may include a vector of non-interest rate variables ( $v$ ) which may be manipulated by lenders to achieve equality between desired mortgage demand and supply, implying the

existence of a regime of equilibrium rationing. Nellis and Thom (1983) comment that this methodology, "treats the 'price vector' as multi-dimensional, including non-interest variables (such as the loan-income ratio) as well as the interest (mortgage) rate". The benefits of the use of a price vector (rather than simply the mortgage rate of interest) has been confirmed empirically by Zumpano *et al* (1986) who estimate simultaneously models of demand and supply on US data with and without the non-interest price terms, finding the former specification to be superior. In concluding they write that, "to specify price properly and avoid a bias in the estimates, the non-contract rate terms should be included with the contract rate in the demand and supply equations". After all, it is noted by Zumpano *et al* that, "market clearing through the use of interest rates, non-rate loan terms, or a combination of both is still effectively credit allocation through price if it is the potential borrower who decides the price is too high". The equation for mortgage demand then becomes

$$M^d = d(r_m, v, z^d) \quad (7.3)$$

The study by Ostas and Zahn (1975) was one of the first to treat the non-interest terms of the mortgage contract as market equilibrating. In fact they propose that equilibrium rationing exists in the short run as the interest rate adjusts sluggishly to its market clearing level. The non-interest terms will adjust instantaneously to temporarily equilibrate the market until the mortgage rate finally adjusts, at which point the non-interest terms will return to their long run levels. There are three main problems of the Ostas and Zahn paper. Firstly, the existence of disequilibrium mortgage rationing is ignored completely. Secondly, interest rate changes are modelled in a partial adjustment framework, and as such the interest rate will be postulated to adjust even if there exists a situation of equilibrium rationing. This has clearly not been the case in the UK mortgage market as mortgage lenders have in the past been content in the long run to lend at lower rates of interest and ration by manipulating the terms of the mortgage. For example, building society interest rates have in the past remained constant over a number of periods while non-interest mortgage terms have served to ration the excess mortgage demand out of the market<sup>6</sup>. In other words, equilibrium

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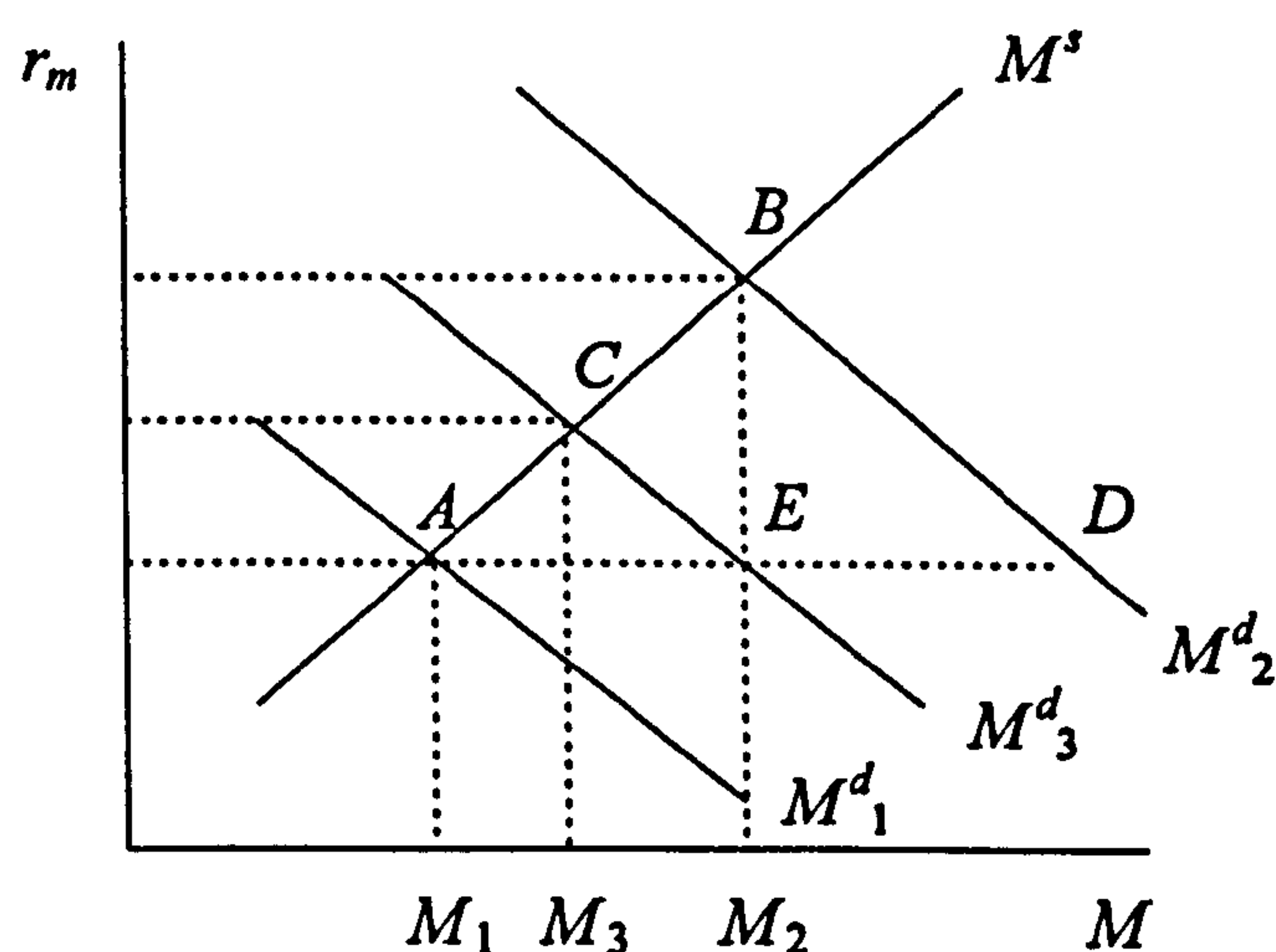
<sup>6</sup> Most notably, building societies interest rates remained constant at 6 per cent for the 12 quarters between 1962Q2 and 1965Q1, and at 11 per cent for the 9 quarters between 1974Q1 and 1976Q1. The



rationing should be considered as part of the mortgage lenders' long term optimising plan. A final criticism of the Ostas and Zahn paper is that a two stage least squares procedure is used to estimate demand and supply, which may lead to incorrect inferences in the light of the developments in the area of long run cointegration modelling over the past decade.

It will prove informative to illustrate the way in which both the demand and supply sides of the mortgage market interact in the presence of equilibrium (and indeed disequilibrium) mortgage rationing.

**Figure 7.1 : Rationing in the Market for Mortgage Finance**



In Figure 7.1 above, the mortgage demand schedule is depicted as a negative function of the mortgage interest rate and the mortgage supply curve a positive function. Beginning at the equilibrium point  $A$ , assume that mortgage demand increases to  $M^d_2$  following a shock to  $z^d$ , the vector of independent demand-side variables<sup>7</sup>. In a competitive market, the mortgage rate will adjust upwards to achieve an equilibrium at point  $B$ . With equilibrium rationing, in the extreme case the mortgage interest rate will be completely unresponsive to the increase in demand and it is left to the vector of non-interest rate variables ( $v$ ) to adjust in order to ration funds by shifting the

latter period is probably the most exceptional due to the especially high rates of inflation making the mortgage lending rate negative for the whole period.

<sup>7</sup> A similar exposition can be given if we begin with an initial supply side (rather than demand side) shock.

demand curve back to its original position ( $M_1^d$  and thus point  $A$ )<sup>8</sup>. Without any change in either  $v$  or the rate of interest following the demand shift to  $M_2^d$ , there would be a disequilibrium of quantity  $D - A$ ; the rule of voluntary exchange would then mean that quantity  $M_1$  would be traded. Changes in the vector of non-interest mortgage terms will also be expected to influence the supply of mortgage funds (see later for a more detailed discussion of the reasons for this). However, we may also expect that any shift in the demand curve as a result of a given change in the non-interest mortgage terms will be greater than the shift in the supply curve<sup>9</sup>, and thus for ease of exposition we assume no effect on the supply curve in the diagram.

The motive behind the use of equilibrium rationing terms in the multi-dimensional vector of prices in determining mortgage demand is that the extent to which mortgages are (equilibrium) rationed by lenders not only physically restricts mortgage demand but also reflects an important cost to the borrower. The greater the degree of equilibrium mortgage rationing (usually reflected by a fall in the average loan to value or loan to income ratio), the higher the cost to the borrower for two reasons :

- there are higher search costs, as additional funds must be acquired from a source other than the mortgage lender.
- additional funds needed to satisfy the required downpayment are likely to be more expensive, as unsecured loans generally attract a higher rate of debit interest than does long term secured mortgage debt<sup>10</sup>. However, if the borrower held sufficient savings upon which he could draw to pay the initial downpayment, the *additional*

<sup>8</sup> The negative effect of increasing the downpayment ratio on the demand for housing (and thus the demand for mortgage finance) is confirmed theoretically in a number of papers. Brueckner (1986), for example, reports the results of his theoretical model that, "when the intertemporal allocation of consumption is distorted by the downpayment constraint, the homeowner will attempt to lessen the impact of the distortion by reducing his house size, which lowers the required downpayment".

<sup>9</sup> The reason for this is that the effect on the supply curve following a change in the loan to value ratio is unclear and depends on whether mortgage lenders view equilibrium rationing terms as substitutes for or complements to other means of rationing funds (such as interest rates). Section 7.1.4 deals with these two opposing hypotheses in more detail.

<sup>10</sup> Home buyers will not usually be granted an unsecured personal loan for the explicit purpose of funding the downpayment on a house. Rather, a personal loan for the purchase of consumer goods (such as a car loan) may be requested with the funds originally set aside for these purposes being freed up and diverted towards the downpayment.



cost to him from using his own funds rather than mortgage funds would be the difference between the after-tax savings rate he receives on his own funds and the after-tax borrowing rate on the mortgage. For any level of general interest rates, the savings rate may be higher than the mortgage rate during the initial years of the loan given that the mortgage rate is often discounted during this period.

Despite the success of a number of papers in modelling equilibrium mortgage rationing terms in the mortgage demand function, it is important not to lose sight of the fact that there have been some studies which have failed to find any significant effect of such variables. For example, Dhrymes and Taubman (1969) in their estimations using US Savings and Loans data find no evidence to suggest that terms and conditions on mortgage contracts (namely the maturity of the loan or the loan to value ratio) have an independent effect on mortgage demand<sup>11</sup>. This is also true of Silber's (1968) study of the demand for mortgages provided by US mutual savings banks, commercial banks and savings and loans institutions. Only the demand for mortgages provided by life insurance companies was found to be affected by the terms and conditions of the mortgage contract (specifically the loan to value ratio and the length of amortisation).

### *Disequilibrium Mortgage Rationing*

Despite the fact that the mortgage interest rate and the vector of non-interest rate variables work together to regulate demand and thereby ration mortgage credit, the existence of a regime of disequilibrium rationing would indicate that the adjustment of these variables is insufficient to ensure mortgage market clearance. Referring back to Figure 7.1 above, following the initial shock to mortgage demand (a demand curve shift from  $M_1^d$  to  $M_2^d$ ) the vector of non-interest rate variables will be adjusted in the usual manner in an attempt to clear the market. With disequilibrium rationing they fail to do so, and the adjustment of the vector of equilibrium rationing variables only shifts the demand curve back to  $M_3^d$ , say, and not all the way to  $M_1^d$  as is the case

<sup>11</sup> This was the case despite their finding of a distinct correlation between the loan to value ratio and mortgage interest rates (a change in the mortgage interest rate of between 0.3 and 0.4 per cent was found to be associated by a change in the loan to value ratio of 0.1).

with equilibrium rationing. The adjustment of  $v$  does serve to ration an amount  $ED$  out of the market but leaves an excess demand of  $AE$ . This excess demand cannot be met under the current supply conditions, but instead lenders must resort to other more strict non-price rationing techniques such as mortgage queues or length of savings record in order to ration mortgage funds (i.e. disequilibrium rationing).

An important question which must be asked is why can we not treat those disequilibrium rationing variables in an identical manner to the way in which we treated the vector of equilibrium rationing terms ( $v$ )? In other words, why can we not simply expand the vector  $v$  to incorporate such disequilibrium rationing terms as length of mortgage queues or the length of an individuals savings record with a particular institution? After all, this would solve the problems involved in estimating a disequilibrium model of the mortgage market as there would only exist equilibrium mortgage rationing. In fact, the methods by which a lending institution engages in equilibrium rationing are not fundamentally different from those disequilibrium rationing methods. Both lay down requirements that must be met by borrowers in order that they may qualify for a mortgage of a certain value.

However, measures of equilibrium and disequilibrium rationing do differ in two important respects. Firstly, where equilibrium measures generally ration the *amount* of mortgage finance willing to be on-lent to any particular borrower (usually dependent upon their financial characteristics), disequilibrium rationing tends to be less financially discriminatory and more discrete in nature as borrowers are limited in their access to *any* amount of mortgage funds. The only way in which the mortgagee may satisfy the disequilibrium rationing requirements and thus acquire any mortgage at all is to wait. Secondly, disequilibrium rationing terms are generally more difficult to measure than their equilibrium counterparts. For example, consistent information on mortgage queues has only been available since October 1983 (after which point there has generally been an absence of disequilibrium mortgage rationing). After accounting for all *measurable* rationing terms, the market may remain in disequilibrium as the mortgage lender engages in forms of rationing that are either unmeasurable or are poorly statistically documented.

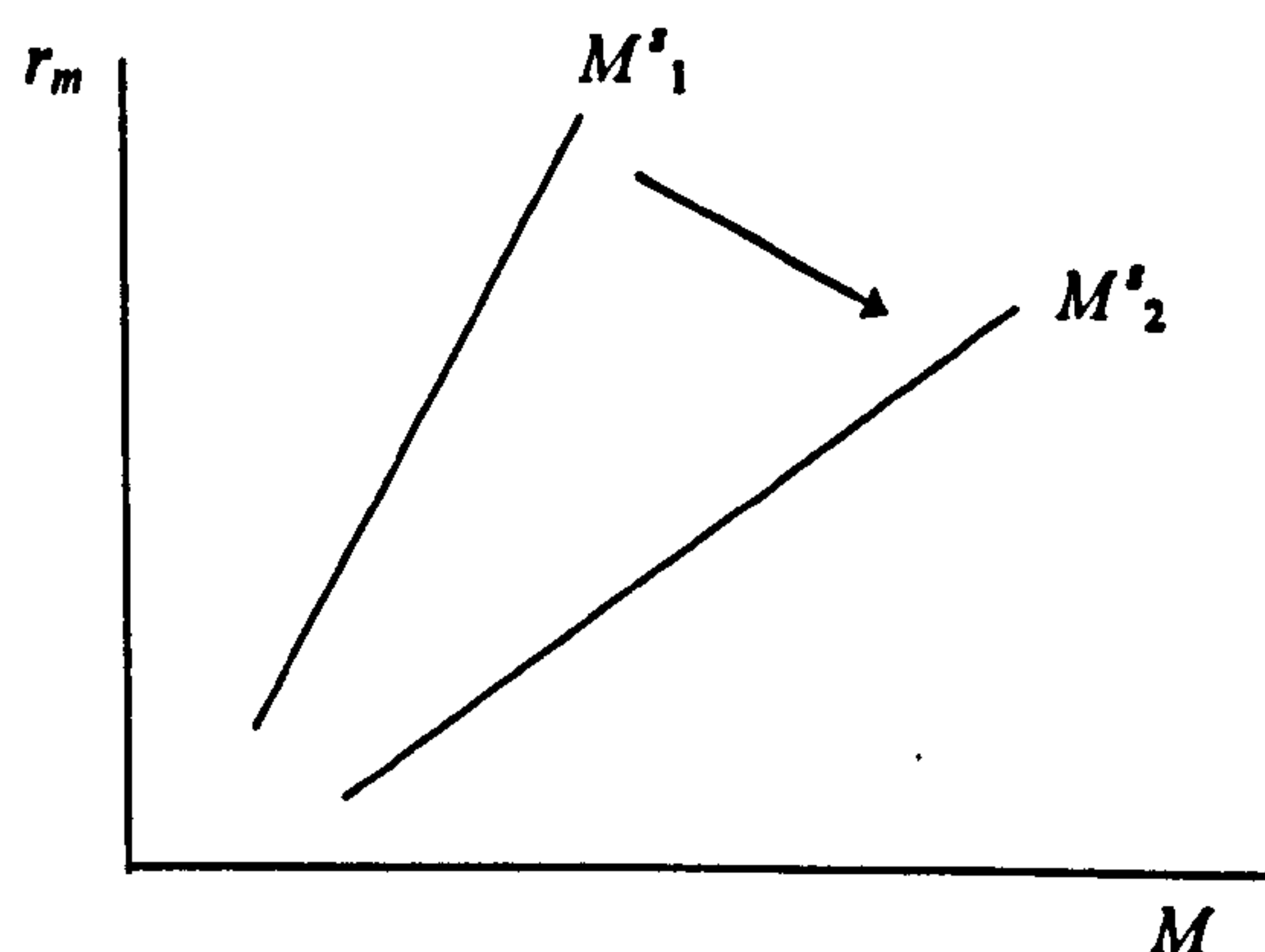


#### 7.1.4 Empirically Accounting for Mortgage Rationing : The Supply Curve

This now leaves the supply curve to be defined under mortgage rationing. One would expect that due to the increasing presence of other mortgage lenders in the market<sup>12</sup> and the break-up of the Building Societies Association cartel towards the end of 1983 that we could roughly identify the end of disequilibrium rationing in the UK mortgage market in 1983/84 (although Meen (1989, 1990b) suggests that mortgage rationing ended in 1981, re-emerging in 1987/88 as the housing market heated up). As such, it is thus informative to look at how the supply curve has changed over the two time periods (i.e. prior to and post 1983/84).

Firstly, consider the case in which there operates a regime of disequilibrium mortgage rationing. During the period prior to 1984, the supply of total funds to building societies was fairly inelastic as mortgage lenders found it difficult or costly to obtain additional funds to on-lend. In turn, it is likely that the supply of mortgages to borrowers during this period was considerably inelastic as depicted by curve  $M_1^s$  in Figure 7.2 below.

**Figure 7.2 : Rationing and the Elasticity of the Supply Curve**



<sup>12</sup> In the third quarter of 1997, building societies accounted for only 25.2 per cent of total mortgage lending outstanding, banks 68.1 per cent and other financial institutions 6.7 per cent. Building societies' mortgage lending was especially low due to recent transfers from mutual to Plc status (most notably the Halifax, the largest mortgage lender in the UK).

In addition, the supply curve could have been expected to become *more* inelastic along its length (i.e. as supply is increased) as lenders were only willing to supply additional mortgage credit at an accelerating interest rate to reflect the fact that increasingly larger deposit interest rate changes were required to attain the same additional amount of deposit liabilities the greater were their levels of deposit holdings<sup>13</sup>. The reason for this prior to the 1980s was that building societies were the main mortgage market players and were restricted in the volume of funds that they could acquire from the wholesale market to finance their mortgage business. Thus when retail savings approached their maximum level and rises in the real interest rate could not command a considerably higher level of savings, mortgage lenders could not look to any other source to boost their available funds. Thus one could reasonably have expected an exponential supply curve, becoming vertical as the real rate of interest approached infinity.

For any *finite* rate of mortgage interest, we would never expect the mortgage supply curve to become vertical as it is assumed that the lender can always command additional liabilities with which they can fund their mortgage business by offering a high enough deposit rate (the extra cost of funds being met by an increase in the interest rate on mortgages).

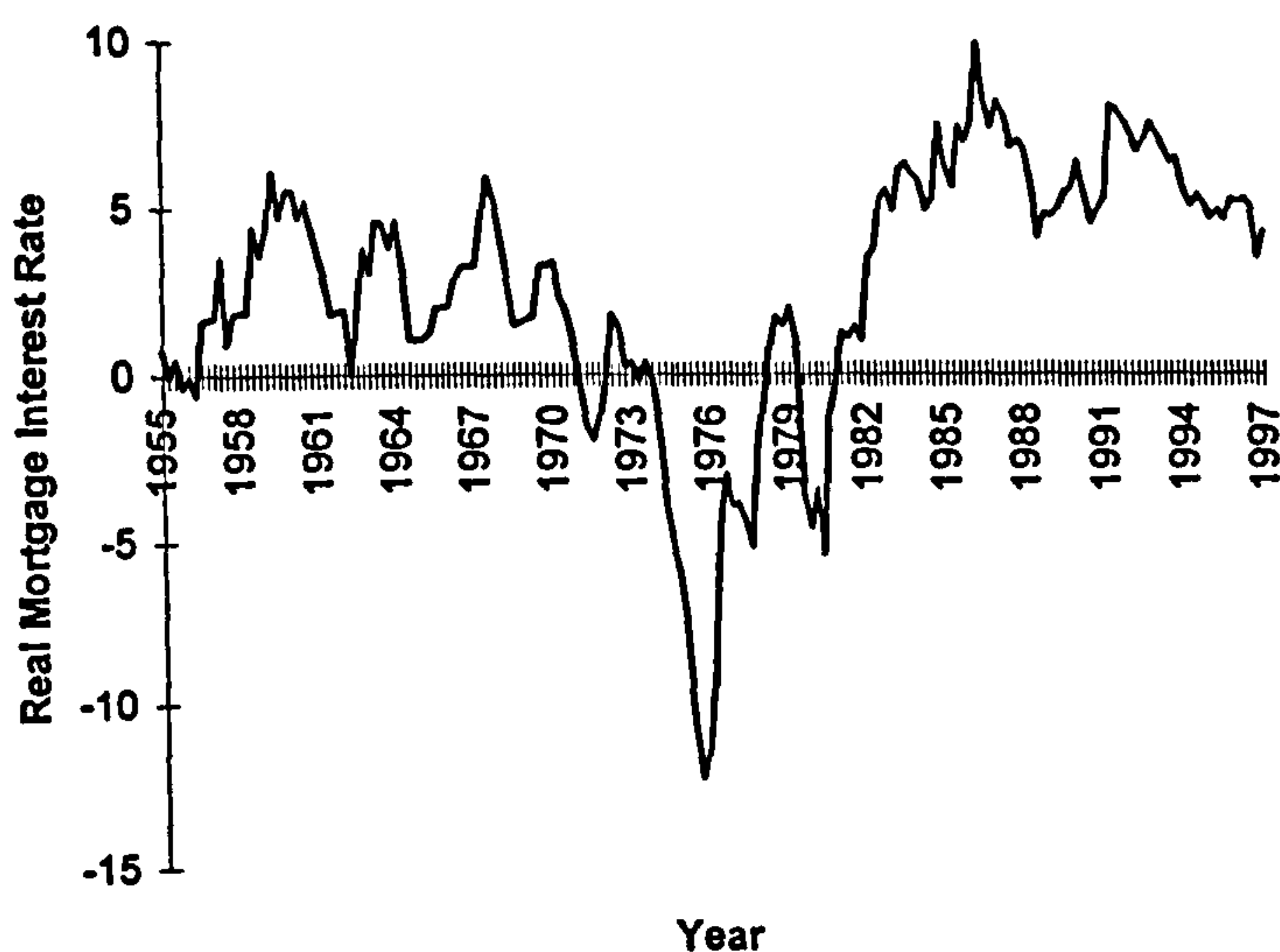
Although it may appear reasonable to assume that mortgage lenders will not lend at all when the real interest rate is zero, in the past it has been the case that building societies have advanced mortgage funds at significantly negative real rates of interest. For example, the spiralling inflation of the 1970s led to building societies maintaining a negative real mortgage rate between the fourth quarter of 1973 and the first quarter of 1978, reaching its lowest level of -12.2 per cent in the third quarter of 1975 (see Figure 7.3 below). Thus it is the case that the mortgage supply schedule need not necessarily pass through the origin of Figure 7.2 above.

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<sup>13</sup> Of course, this relies on there being sufficient inelastic mortgage demand such that the additional cost of funds can be recouped through real mortgage interest rate rises.



**Figure 7.3 : The Real Mortgage Interest Rate (Building Societies) (%)**



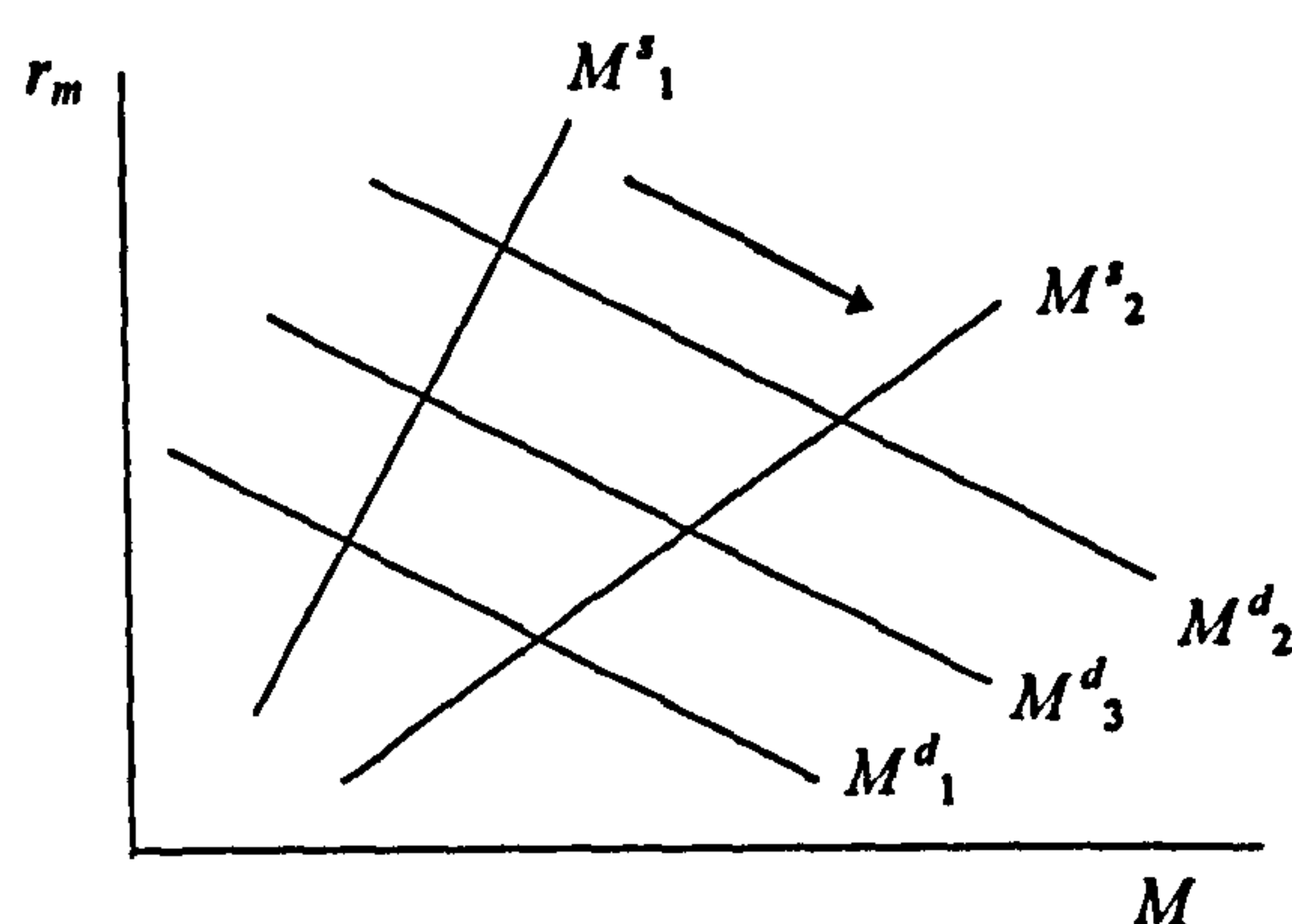
As banks and other mortgage lenders entered the mortgage market in the early 1980s and legislation was introduced to free up the market (banks were permitted to undertake mortgage lending and building societies were allowed greater access to wholesale funding), mortgage funds became more freely available to borrowers. The supply of deposits schedule became more elastic with respect to both the rate of interest and non-price variables (such as account access) and thus as a result the mortgage supply schedule became flatter reflecting the relative ease with which mortgage lenders could attain additional mortgage funds at little extra cost<sup>14</sup>.

This is shown in Figure 7.2 in which at every interest rate, the mortgage lender is willing to supply a greater level of mortgage loans. By combining Figures 7.1 and 7.2 it can be seen that the flatter is the mortgage supply function the smaller will be the required change in the rate of interest in order to re-impose mortgage market equilibrium following a demand shock (Figure 7.4 below). Thus for any initial upward shift in demand, a smaller change in the rate of mortgage interest may offset or reduce the need to resort to either equilibrium or disequilibrium rationing as the mortgage supply curve becomes less steep. This has been borne out in reality as both equilibrium and disequilibrium rationing of mortgages have become less prevalent

<sup>14</sup> Section 6.4.2.2 reviews the arguments for the choice of variable to reflect the ease of societies attaining additional funds to on lend as mortgages.

since 1980, the decline in equilibrium rationing being reflected by a considerable rise in both the loan to income and loan to value ratios over the 1980s and 1990s<sup>15</sup>.

**Figure 7.4 : Rationing and the Demand for and Supply of Mortgages**



One may expect from the above discussion that changes to the structure of mortgage finance during the 1980s and 1990s have encouraged a regime shift in the mortgage supply curve from  $M_1^s$  to  $M_2^s$  in Figure 7.4 as the necessity to ration mortgage funds has been reduced. Thus, on the assumption that the supply curve can be identified, we would expect to observe a steady increase in the coefficient on the real interest rate variable in the long run structural mortgage supply equation.

It was mentioned briefly in Section 7.1.3 that non-interest mortgage loan terms may be expected to influence the supply of mortgage finance. However, the relationship between the desired level of mortgage supply, the mortgage interest rate and the mortgage loan contract terms (equilibrium rationing terms) is not unambiguous, and may be characterised in one of two ways. Firstly, changes in the non-interest mortgage contract terms will alter the overall risk composition of mortgage lenders' asset portfolios. In general, the higher the loan to value or loan to income ratio the higher will be the lender's risk, since for any given level of mortgage lending a larger average loan size would concentrate risk in fewer obligations<sup>16</sup>. In turn this would be

<sup>15</sup> Some banks now offer mortgages with loan to value ratios of up to 100 per cent, and the average loan to income ratio has remained high at between 2 and 2.5 since 1986, prior to which it had reached a low of 1.64 in the second quarter of 1980.

<sup>16</sup> This is contested by Stiglitz and Weiss (1981) based on adverse selection and moral hazard arguments, who argue that, "increasing collateral requirements [reducing the loan to value ratio, for



expected to lead to a fall in mortgage lenders' willingness to lend funds for house purchase. This may be referred to as the 'trade-off argument' since in this case the financial intermediary is willing to lend less the looser (and thus more risky) are the credit terms. Non-interest mortgage terms are thus *substitutes* for other rationing terms (such as interest rates).

However, we may alternatively expect that as credit terms are loosened (a rise in the loan to value or loan to income ratios) mortgage lenders will desire to increase mortgage lending, since their net return on the mortgage portfolio will be higher as overheads and mortgage origination costs can be spread over a larger volume of repayments. In other words, lenders' average costs will fall the looser are the non-interest credit terms. As Hall and Urwin (1989) note, "a higher loan to value or loan to income ratio will indicate that the societies are currently keen to expand lending relative to deposits". This may be referred to as the 'reinforcing argument' (and is similar to Guttentag's (1960) multiple term hypothesis) since movements in the non-interest credit terms are indicative of the general willingness of the financial intermediary to lend mortgage funds. Such terms are used as *complements* to other methods of rationing. Given these two arguments, the cumulative effect on supply of changes in the non-interest mortgage terms will therefore be indeterminate *ex ante*; if the supply function can be identified in a cointegrating framework then the direction of the sign on the loan to value variable in the estimated supply function would confirm which of the two propositions dominates. However, we will see later in Section 7.2.5 that estimation of the reduced form equation will be sufficient to identify the relative importance of the two arguments.

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example, ed.] could increase the riskiness of the bank's loan portfolio, either by discouraging safer investors, or by inducing borrowers to invest in riskier projects". They conclude, therefore, that financial institutions will ration credit by limiting the number of loans made rather than their size.

## 7.2 EMPIRICAL ANALYSIS

### 7.2.1 Structural Supply and Demand Functions and the Reduced Form Model

To be able to estimate the demand and supply curves over any time period we must assume that both functions can be identified. Identification requires that at least one exogenous variable in the demand equation (i.e. a component of the vector  $z^d$ ) is excluded from the supply equation (i.e. does not appear in  $z^s$ ) and vice versa<sup>17</sup>. We must therefore be able to set demand equal to supply in Figure 7.4 above such that the equilibrium values trace out both the underlying demand and supply curves. However, by doing so we are implicitly assuming that a combination of the real rate of interest and equilibrium rationing variables is sufficient to clear the mortgage market, i.e. that we are in a position of equilibrium rationing; from the previous discussion this was obviously not the case during the period prior to 1983/84. We would expect the supply function to be identified over the whole period (both prior to and post 1984) despite exhibiting a structural break (see previous discussion). The demand function is expected to be identified for the period post 1984 (when rationing disappeared and the market became competitive) and unidentified in the period preceding 1984. This being the case, in order to estimate the demand function over the estimation period prior to 1984 one of two assumptions must be made regarding the state of mortgage rationing during that period :

- That disequilibrium rationing did not exist in the mortgage market. This is the finding of Nellis and Thom (1983) in which the demand for UK mortgage finance is modelled as a function of the interest rate and a number of non-interest equilibrium rationing terms<sup>18</sup>.

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<sup>17</sup> The information contained in these excluded variables must be able to shift the demand and supply functions independently of any other explanatory variable. In other words, excluded variables must not be perfectly correlated with any other variable in the system.

<sup>18</sup> Nellis and Thom (1983) argue that lending criteria (i.e. equilibrium rationing terms) are different for first time buyers and existing owner occupiers, and as such they disaggregate the estimation of the demand side of the market between the two types of borrower.



- That the equilibrium rationing variables are closely correlated with disequilibrium measures (such as length of queues or length of time required to be a saver with a particular financial institution in order to qualify to be considered for a mortgage) to the extent that equilibrium rationing terms,  $v$ , reflect accurately the disequilibrium measures.

The first conjecture, given the documentary and statistical evidence on the mortgage market during the 1970s, appears implausible and is thus rejected; queues of potential mortgagors apparently being able to satisfy societies' prudential criteria did indeed exist during the 1970s. By making the second conjecture we are essentially assuming that disequilibrium rationing terms are a component of  $v$ . Because such terms do not lend themselves easily to measurement the assumption here is that they can be captured by measurable 'equilibrium' rationing terms. This notion is particularly appealing since it negates the need to divide rationing terms into two types - all rationing would then simply become 'equilibrium' rationing. Mortgage queues and savings history requirements simply become an additional cost to the borrower which the lender would choose as just another component of the vector of non-interest terms,  $v$ .

However, these assumptions may not be well founded. There is no compelling reason to believe necessarily that disequilibrium rationing must be associated with strict equilibrium rationing. In fact it could be the opposite case that the offer of a high loan to value ratio has in the past led to the need of building societies to ration credit through disequilibrium means. In short, this thesis takes the view that, without resorting to disequilibrium econometric techniques (which may be incompatible with the relatively recent theory on cointegration procedures to deal with long run relationships between non-stationary variables) there is no adequate way of *directly* estimating the demand for mortgages over the period of rationing prior to 1984.

Due to the current state of time series econometric knowledge, it is in practice problematic to observe the structural parameters of the demand and supply functions *irrespective of whether or not mortgage demand is rationed*. Although there exist a

number of techniques to estimate structural models of simultaneous equations when the variables under consideration are stationary (namely two and three stage least squares and seemingly unrelated regression estimation), no such methodology exists for variables integrated of order  $I(1)$  or more. In other words, even if we can theoretically identify equations for supply and demand there exists no technique that allows us to adequately estimate these structural equations in a cointegrating framework. Although Johansen's (1988) maximum likelihood procedure does allow the estimation of up to  $r$  cointegrating vectors from a set of  $r + 1$  variables, the results can often be misleading and uninterpretable (in general, the greater the number of cointegrating vectors amongst a particular set of variables the more acute this problem will become). In preliminary estimations using Johansen's procedure, it was hoped that out of the complete set of variables (both supply and demand) we would be able to observe both structural a supply and structural demand relationship; however, this proved not to be the case, with none of the six cointegrating vectors that emerged from the set of nine variables being particularly informative.

Thus it was deemed more appropriate to estimate a reduced form model in a cointegrating framework over the period in which mortgage rationing was absent. Estimation of the reduced form equation essentially allows us to circumvent the problems of identification and simultaneous estimation, although as previously discussed, it becomes more difficult to interpret the parameters in a structural context. However, given that we have not accounted for disequilibrium rationing in either the underlying supply or demand functions, it could be the case that the reduced form may be misspecified if estimated over a period in which there was a change in the regime of mortgage rationing which caused the functional relations to change.

Despite the inability to estimate and interpret the structural parameters of the supply and demand functions, this chapter will show that a number of interesting and useful results do emerge from the estimation of the reduced form equation. These results are attained by varying the period of estimation and backcasting using the estimated model over the unrationed period to infer the degree to which mortgages were rationed during the 1970s and early 1980s.



### 7.2.2 Empirical Specification

As discussed in the previous section, the supply and demand functions are specified as

$$M_t^s = s(r_{mt}, v_t, z_t^s) \quad (7.4)$$

and

$$M_t^d = d(r_{mt}, v_t, z_t^d) \quad (7.5)$$

where  $r_{mt}$  is the after-tax rate of interest on mortgage loans,  $z_t^d$  and  $z_t^s$  are the vectors of demand and supply side variables (the inclusion of which has been suggested by theoretical considerations regarding the demand for housing and mortgages and the supply of mortgage finance respectively) and  $v_t$  is the vector of non-interest mortgage terms (as proxied by the loan to value ratio). The precise *empirical* specification of the structural equations of the demand for and supply of mortgages is as follows :

*Supply :*

$$\begin{aligned} \ln R(AAPR)_t = & \alpha_0 + \alpha_1 R(r_m)_t + \alpha_2 \ln ZLVF_t \\ & + \alpha_3 \ln COLLAT_t + \alpha_4 \ln R(AAAU)_t + u_{1t} \end{aligned} \quad (7.6)$$

*Demand :*

$$\begin{aligned} \ln R(AAPR)_t = & \beta_0 + \beta_1 R(r_m)_t + \beta_2 \ln ZLVF_t \\ & + \beta_3 \ln R(PAHM)_t + \beta_4 \ln R(ALDO)_t \\ & + \beta_5 \ln INFL_t + \beta_6 R(UC)_t + \beta_7 \ln MIRAS + u_{2t} \end{aligned} \quad (7.7)$$

where

- $R$  denotes a real value (as deflated by the consumers expenditure price deflator)<sup>19</sup>
- $\ln$  denotes the natural logarithm of a variable
- $AAPR$  represents total net advances of loans secured on dwellings (£m) from all sources
- $r_m$  is the after-tax interest rate on building society mortgages (per cent)
- $ZLVF$  is the average loan to value ratio of building societies' first time borrowers (per cent)

<sup>19</sup> Real variables are at 1990 prices and have all been deflated by the consumers' expenditure price deflator with the exception of  $R(UC)$  which is specified as a percentage of the real house price.

- *COLLAT* is the ratio of the value of the personal sector dwelling stock to the value of total loans outstanding secured on dwellings (per cent)
- *AAAU* is personal sector savings (£m)
- *PAHM* is a mix adjusted index of house prices
- *ALDO* is the total level of financial assets (£m)
- *INFL* is the inflation rate implied by consumers' expenditure price deflator (per cent)
- *R(UC)* is a measure of the real user cost of housing capital (per cent)
- *MIRAS* is the total cost of the MIRAS scheme as a proportion of outstanding mortgage debt (per cent)

All data pertain to the UK and are seasonally adjusted using the X11 procedure in SAS (see Appendix 6.2 for a discussion of this technique). The reduced form equations for the three endogenous variables  $M_t$ ,  $r_{mt}$  and  $v_t$  (where  $M_t = M_t^s = M_t^d$ ) can then be written as  $M_t = f_1(z_t^d, z_t^s)$ ,  $r_{mt} = f_2(z_t^d, z_t^s)$  and  $v_t = f_3(z_t^d, z_t^s)$ , the empirical specification becoming

$$\begin{aligned} \ln R(AAPR)_t = & \gamma_0 + \gamma_1 \ln COLLAT_t + \gamma_2 \ln R(AAAU)_t \\ & + \gamma_3 \ln R(PAHM)_t + \gamma_4 \ln R(ALDO)_t \\ & + \gamma_5 \ln INFL_t + \gamma_6 R(UC)_t + \gamma_7 \ln MIRAS_t + v_{1t} \end{aligned} \quad (7.8)$$

$$\begin{aligned} R(r_m)_t = & \delta_0 + \delta_1 \ln COLLAT_t + \delta_2 \ln R(AAAU)_t \\ & + \delta_3 \ln R(PAHM)_t + \delta_4 \ln R(ALDO)_t \\ & + \delta_5 \ln INFL_t + \delta_6 R(UC)_t + \delta_7 \ln MIRAS_t + v_{2t} \end{aligned} \quad (7.9)$$

$$\begin{aligned} \ln ZLVF_t = & \xi_0 + \xi_1 \ln COLLAT_t + \xi_2 \ln R(AAAU)_t \\ & + \xi_3 \ln R(PAHM)_t + \xi_4 \ln R(ALDO)_t \\ & + \xi_5 \ln INFL_t + \xi_6 R(UC)_t + \xi_7 \ln MIRAS_t + v_{3t} \end{aligned} \quad (7.10)$$

In the following analysis, reduced form estimations are initially conducted over the periods 1969Q1-1995Q4 (the full sample period of 108 observations), 1969Q1-1983Q4 (the first subsample period of 60 observations) and 1984Q1-1995Q4 (the



second subsample period of 48 observations). From the discussion of Section 7.1 it is hypothesised that the first subsample period be characterised by a regime of disequilibrium mortgage rationing and the second subsample by either equilibrium mortgage rationing or competitive equilibrium. This does not mean that we cannot estimate the reduced form model over the rationed period, although it is the case that any results from doing so must be interpreted with care since, as we discussed above, the reduced form equation may be misspecified<sup>20</sup>. The division of the full sample in to two subsamples at these dates was the natural way to progress; one would hypothesise a structural break in the market in around 1984 given the breakdown of the Building Societies Association cartel at this time and the recent entrance of banks into the mortgage market and of building societies into the wholesale deposit market.

### 7.2.3 Testing for Cointegration : The Residual Approach

Engle and Granger (1987) propose seven asymptotic residual based tests for testing the null hypothesis that a certain set of variables do not cointegrate against the alternative hypothesis of cointegration. It was noted in their paper that it is the Augmented Dickey-Fuller (ADF) test which is preferable in most situations to any of the other six tests.

The first step of the Engle and Granger methodology is to pre-test the variables to be included in the reduced form cointegrating relationship for their order of integration. Cointegration requires that the variables all be integrated of the same order. Augmented Dickey-Fuller and Phillips-Perron  $F$ - and  $t$ -tests are used to test for the order of integration; the results are discussed in Appendix 6.3. The results of the tests (and plots of the series and autocorrelation functions for the first differences of the variables  $\ln COLLAT$  and  $\ln R(PAHM)$ ) confirm that the variables are all non-stationary and specifically integrated of order 1.

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<sup>20</sup> Misspecification can cause the resulting parameter estimates to be inconsistent to the extent that the omitted variables are correlated with those included in the estimations.

The point estimates of the long run relationship between the variables may then be consistently estimated using OLS in the form

$$y_t = \beta_0 + \beta_1 z_t + e_t \quad (7.11)$$

where  $y_t$  is the dependent variable and  $z_t$  represents a vector of independent variables. If the variables are cointegrated, then as proved by Stock (1987), the probability limits of the parameter estimates converge more quickly to the true parameter values than an equivalent regression using stationary variables (i.e. the estimators are 'super-consistent'). The Engle and Granger test for cointegration is a test of whether the residual series from the OLS regression of equation (7.11),  $\hat{e}_t$ , are stationary, in which case we may conclude that the series  $y_t$  and  $z_t$  are cointegrated. Because the ADF test is performed on the residual series we should not include either a constant or a time trend in the residual ADF equation (the residuals will necessarily by assumption have a mean of zero), and thus the ADF equation may be written as follows

$$\Delta \hat{e}_t = a_0 \hat{e}_{t-1} + \sum_{i=1}^p a_i (\Delta \hat{e}_{t-i}) + \varepsilon_t \quad (7.12)$$

When adding lags up to an order of  $p$ , the series  $\{\hat{e}_1, \hat{e}_2, \dots, \hat{e}_{t-p}\}$  will not have a mean of exactly zero, but will always be very close to zero except where  $T$  (the number of usable observations) is small or where  $\hat{e}_{t-p}, \hat{e}_{t-p+1}, \dots, \hat{e}_t$  are unusually large in absolute value. Hence adding a constant to equation (7.12) will have only a negligible effect.

If the hypothesis that  $a_0 = 0$  cannot be rejected, then we may conclude that the residual series contains a unit root and we may therefore not reject the hypothesis that the variables are not cointegrated. Rejection of the hypothesis  $a_0 = 0$  implies a stationary residual series and thus the conclusion is reached that the variables must be cointegrated of order  $CI(1,1)$ .



Since the series  $\hat{e}_t$  is generated from an OLS regression, we only know an estimate of the error and not the actual error. As a result, it has been shown (see Engle and Granger (1987)) that the use of the usual Dickey-Fuller critical  $t$ -values for a unit root test prejudices the outcome of finding a stationary error process. Engle and Granger prove that the distribution of the  $t$ -ratio for the test of  $\alpha_0 = 0$  is non-standard and present critical values based on Monte Carlo simulation results. Subsequently, critical values for the ADF test have been published in Engle and Yoo (1987) and MacKinnon (1991).

Table 7.1a : Results of Engle and Granger's (1987) Residual Based Test for Cointegration : The Reduced Form Mortgage Equation<sup>21</sup>

Statistic	1969Q1-1995Q4		1969Q1-1983Q4		1984Q1-1995Q4	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
DF	-4.0926	-4.2598	-2.4297	-2.7888	-4.1247	-4.3388
ADF(1)	-5.0050	-4.7625	-3.2282	-3.5216	-4.7722	-5.0992
ADF(2)	-4.4074	-4.2379	-3.4299	-3.7306	-3.3150	-3.4403
ADF(3)	-4.2743	-3.7881	-3.3500	-2.7567	-3.6872	-3.8061
ADF(4)	-3.7584	-3.5288	-3.2357	-2.5266	-3.4188	-3.5308
ADF(5)	-3.9080	-3.4183	-3.3188	-2.8515	-2.9678	-3.0335
ADF(6)	-4.3550	-3.6474	-4.1205	-3.5030	-3.1078	-3.1522
ADF(7)	-4.3951	-3.9046	-5.6697	-5.0709	-3.2910	-3.2927
ADF(8)	-3.7057	-3.1289	-4.0771	-3.6284	-3.1996	-3.1865
AIC	1	1	7	7	1	1
SC	1	0	1	1	1	1
HQC	1	1	7	7	1	1
LM	0	0	0	0	0	0
Critical $t$ 5%	-5.3433	-5.6641	-5.5645	-5.8997	-5.7048	-6.0493
Critical $t$ 10%	-4.9882	-5.3413	-5.1297	-5.5228	-5.2189	-5.6372

where AIC, SC, HQC and LM are the Akaike Information Criterion, the Schwartz Criterion, the Hannan-Quinn Criterion and the LM decision respectively (the latter being the smallest number of lags in the residual ADF equation such that serial correlation is eliminated). The columns entitled 'Constant' and 'Constant and Trend'

<sup>21</sup> Critical values for the ADF statistics on the residual series are given in the tables in the text for a 5 and 10 per cent significance level. However, MacKinnon (1991) does not provide response surface estimates when there are more than six variables included in the original cointegrating OLS regression. Given that there are eight variables in each of the three reduced form equations here, MacKinnon's critical values are updated by undertaking an OLS estimation of each on a constant,  $N$  (the number of variables in the cointegrating equation) and  $N^2$ , following which a prediction of the critical values is made for  $N = 8$ . Six regressions are undertaken (there are three sample sizes and the "no trend" and "with trend" cases) on the critical values attained at the 5 per cent level of significance and six on those at 10 per cent.

refer to the specification of the underlying cointegrating model; the reduced form functions (which exclude a time trend) are specified in equations (7.8) through (7.10) in Section 7.2.2 above.

**Table 7.1b : Results of Engle and Granger's (1987) Residual Based Test for Cointegration : The Reduced Form Mortgage Interest Rate Equation**

Statistic	1969Q1-1995Q4		1969Q1-1983Q4		1984Q1-1995Q4	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
DF	-3.0440	-3.5968	-3.2305	-3.1929	-3.1871	-3.1223
ADF(1)	-2.9905	-3.5096	-3.5460	-3.5014	-3.9151	-4.1776
ADF(2)	-3.1797	-3.6546	-3.6863	-3.6325	-3.0153	-3.6335
ADF(3)	-3.6802	-4.3580	-4.6577	-4.6059	-3.8725	-3.9900
ADF(4)	-2.7390	-3.2777	-3.1066	-3.0678	-2.9632	-3.1539
ADF(5)	-2.5937	-2.6957	-2.4848	-2.4581	-1.8967	-1.7991
ADF(6)	-3.4258	-3.1954	-2.8407	-2.8227	-2.4961	-2.5082
ADF(7)	-3.7511	-3.5964	-2.4410	-2.4363	-3.0973	-3.6319
ADF(8)	-3.3820	-3.3294	-2.1692	-2.1874	-2.9104	-2.8104
AIC	7	7	4	4	7	7
SC	0	0	0	0	1	7
HQC	6	0	3	3	7	7
LM	4	4	3	3	0	0
Critical $t$ 5%	-5.3433	-5.6641	-5.5645	-5.8997	-5.7048	-6.0493
Critical $t$ 10%	-4.9882	-5.3413	-5.1297	-5.5228	-5.2189	-5.6372

**Table 7.1c : Results of Engle and Granger's (1987) Residual Based Test for Cointegration : The Reduced Form Loan to Value Ratio Equation**

Statistic	1969Q1-1995Q4		1969Q1-1983Q4		1984Q1-1995Q4	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
DF	-2.3810	-2.2801	-1.9747	-1.7959	-1.6476	-1.6136
ADF(1)	-3.6825	-3.8808	-2.8557	-3.3975	-3.1987	-3.3019
ADF(2)	-4.0515	-4.2278	-3.6093	-3.5656	-4.0815	-4.0797
ADF(3)	-3.8749	-3.5831	-3.5631	-2.9419	-3.2281	-3.2597
ADF(4)	-3.3072	-3.4227	-3.5463	-2.9671	-2.3771	-2.6335
ADF(5)	-4.1908	-4.2660	-4.7324	-4.3730	-2.8443	-3.0653
ADF(6)	-4.5192	-4.6369	-4.2998	-4.0836	-2.9758	-3.1106
ADF(7)	-4.3396	-3.9652	-4.4502	-3.5521	-2.8064	-3.0190
ADF(8)	-3.6816	-3.3687	-3.0573	-2.6980	-2.8158	-2.7954
AIC	6	6	5	5	2	2
SC	1	1	2	1	2	2
HQC	5	1	5	5	2	2
LM	1	1	1	5	2	1
Critical $t$ 5%	-5.3433	-5.6641	-5.5645	-5.8997	-5.7048	-6.0493
Critical $t$ 10%	-4.9882	-5.3413	-5.1297	-5.5228	-5.2189	-5.6372



Turning to the tables presented above, with few exceptions the results of the lag length selection criteria are not particularly consistent; nevertheless, in all but one reduced form equation the LM criterion suggests that we use a low number of lags<sup>22</sup>. The number of lags suggested by the AIC and HQC tests is often large, a result which must be interpreted carefully since if we were to reduce the *possible* number of lags in the frame, the selection criteria would be forced to suggest the use of a lower number of lags. From the results presented above, there is no evidence to suggest that the equations estimated with a constant and a time trend perform any better than those with only a constant (i.e. the residuals do not appear 'more stationary'), and therefore from this point on when estimating cointegrating relationships we will concentrate solely on the estimation of reduced forms with a constant but without a time trend.

The ADF test results on all equations generally suggest that the variables are either almost cointegrated or are cointegrated at a low level of significance<sup>23</sup>. However, there are severe limitations associated with the Engle and Granger methodology for testing for cointegration in small samples (as will be discussed briefly in the following section) and as such, we must not attach too much credence to the results presented above. Nevertheless, given the drawbacks of the Engle and Granger technique the results of this section should be viewed as moderately encouraging.

#### 7.2.4 Testing for Cointegration : The Johansen (1988) Approach

One of the principal problems of the residual based tests for cointegration in finite samples as described and conducted in the previous section is that to apply the tests requires us to decide explicitly which variable we should include on the left hand side and which variables should be the regressors. For example, in testing for

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<sup>22</sup> Out of the AIC, SC and HQC tests, the results of the HQC test are the most similar to those results provided by the LM test, with 5 out of 18 of the results of Tables 7.1a through 7.1c giving the same number of lags. The SC test is less 'reliable', with 4 out of 18 of the results in agreement and the AIC the worst performer, with only 2 of the results agreeing. However, the AIC and HQC tests are the most similar to each other in terms of lag recommendations, with 12 out of the 18 results being the same.

<sup>23</sup> Because the choice of the left hand side variable will influence the result of the cointegration tests, ADF tests could be undertaken on the residuals of all of the equations substituting each independent variable in turn for the current dependent variable in the regressions. However, from preliminary estimations it was clear that there was very little difference in the ADF results when this procedure was followed.

cointegration in the reduced form mortgage equation above we could have used any one of the eight variables as the dependent variable (although an endogenous variable should be used as the regressand if the equation is to make any economic sense). Asymptotically, it will be the case that whichever variable is used to test for stationarity in the residual series we should attain the same result. However, with smaller sample sizes we may find that using a different variable on the left hand side does influence the result, leading to the undesirable property that the tests can potentially suggest contradictory conclusions as to whether or not the variables are cointegrated<sup>24</sup>. The reason for this is that the equations have been estimated using OLS and may thus be subject to small sample bias; as the sample size tends to infinity, the bias will disappear due to the super-consistency property. Moreover, the Engle and Granger methodology does not represent a systematic procedure for estimating multiple cointegrating vectors. Thus the Johansen (1988) maximum likelihood procedure is used since it represents a more unified framework in testing for the existence of cointegrating relations through the estimation of vector error correction models, and as such an outline of the methodology follows.

The vector error correction model (VECM) of the supply and demand model of mortgage lending may generally be written as

$$\Delta y_t = a_0 + a_1 t + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \Psi w_t + u_t \quad (7.13)$$

where  $y_t$  is an  $(m \times 1)$  vector of  $I(1)$  variables (in this case  $y_t$  will include *all* of the variables featuring in the demand and supply equations whether endogenous or exogenous),  $a_0$  is an  $(m \times 1)$  vector of intercept terms,  $a_1$  is an  $(m \times 1)$  vector of coefficients on the linear time trend  $t$ ,  $\Gamma_1, \Gamma_2, \dots, \Gamma_{p-1}$  are  $(m \times m)$  matrices of unknown parameters on the stationary lagged first differences of  $y_t$  (such that at least one element in each matrix  $\Gamma_i$  is non-zero),  $\psi$  is an  $(m \times s)$  matrix of coefficients on an  $(s \times 1)$  vector of  $I(0)$  variables  $w_t$ , and  $u_t$  is an  $(m \times 1)$  vector of error terms which are

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<sup>24</sup> Although the value of the test statistic may vary depending on which series is used as the regressand, the distribution of the test statistic will remain the same.



assumed  $N(0, \Sigma)$ . Under the assumption that the rank of the matrix of long run coefficients ( $\Pi$ ) is  $r$ , then there exist  $r$  cointegrating relations among the variables in  $y_t$ .

The vector of  $I(0)$  variables ( $w_t$ ) is included separately in the VECM of equation (7.13) above but since it does not enter the long run cointegrating vector no long run coefficients are derived for these variables. Since all of the variables to be included in the models presented in this chapter are  $I(1)$ ,  $w_t$  appears in equation (7.13) above merely for reasons of completeness. These stationary variables would usually be included simply to ensure that the error terms of equation (7.13) are white noise<sup>25</sup>.

Using the *complete* set of endogenous and exogenous variables of the supply/demand model of mortgage finance we employ Johansen's (1988) maximum likelihood approach to test for the number of cointegrating relations. From this set of variables, at least three cointegrating relationships would be expected to emerge : equations determining the amount of mortgages traded (equation (7.8)), the mortgage rate of interest (equation (7.9)) and the loan to value ratio (equation (7.10)). If these equations were to be estimated by the Johansen technique, then each one of the three cointegrating vectors would have to be appropriately restricted to allow for their exact identification<sup>26</sup>. To the extent that disequilibrium rationing cannot be adequately captured by a single equilibrium rationing variable, the expectation of there being three correctly identified long run equilibrium relationships may be over-optimistic during those periods in which mortgage rationing was prevalent (namely the first sample period and the full sample period). It is during these periods that there is a possibility that the estimated relationships may be misspecified.

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<sup>25</sup> It was noted in Section 7.2.2 that we could not include in the cointegrating relationship a variable representing the difference between the mortgage rate of interest and the cost of funds to lending institutions since the variable was found to be stationary. The specification of the VECM does, however, allow us to include such a variable in the vector  $w_t$ .

<sup>26</sup> For example, there would have to be zero restrictions on variables  $R(r_m)$  and  $\ln ZLVF$  in equation (7.8),  $\ln R(AAPR)$  and  $\ln ZLVF$  in equation (7.9) and on  $\ln R(AAPR)$  and  $R(r_m)$  in equation (7.10).

#### 7.2.4.1 Step 1 : Choice of Lag Length for the Johansen (1988) Test

The results of the Johansen eigenvalue and trace tests (carried out on the parameter vector  $\Pi$  in equation (7.13)) for the number of cointegrating vectors can be quite sensitive to lag length. The most common procedure adopted in selecting the lag length for the VECM of equation (7.13) is to estimate (using OLS) an underlying vector autoregression (VAR) using the undifferenced  $I(1)$  series  $y_t$ , and to undertake standard tests for the optimal lag length structure. The specification of the unrestricted VAR is as follows :

$$y_t = b_0 + b_1 t + \sum_{i=1}^p \Phi_i y_{t-i} + v_t \quad (7.14)$$

where  $\Phi_i$  are  $(m \times m)$  matrices of unknown parameters on  $y_t$ , the  $(m \times 1)$  vector of lagged variables as given in the complete supply and demand model above. The length of lag used in the VECM specification defined by equation (7.13) will then always be one less than that of the estimated underlying VAR given that the VECM essentially represents the VAR in first differences, i.e. if the optimal lag order of the VAR in levels is found to be  $p$ , then the lag length to be used in the VECM will be  $p - 1$ . The lag length test results that follow are presented for VAR estimations which include both a constant *and* a time trend. It is preferable to specify the underlying VAR with a time trend since this would imply the desirable property of the existence of a constant term when differenced (i.e. in the VECM specification).

There are a number of methods we may adopt in calculating the optimal lag structure in the VAR of equation (7.14) which are discussed fully below. With all selection criteria, we must be aware when choosing the optimum number of lags that the remaining sample for estimation must be large enough for the asymptotic theory to work well. In the analysis which follows, the *maximum* lag length is set to 4 for both the full-sample and subsample estimations due to the limited number of observations. The preference would be to opt for a reasonably short lag structure and certainly no



greater than of order 4<sup>27</sup>. Because some of the lag selection criteria are dependent upon the sample size (notably the Akaike Information Criteria and the Schwartz Criterion), when comparing across equations with different lag lengths we must ensure that the sample size remains constant. In the estimations below, therefore, the tables of lag-length selection results are based on a constant sample size of  $T-4$  for the full sample,  $T_f-4$  for the first subsample and  $T_s$  for the second subsample (where  $T$  is the total number of observations in the whole sample period and the subscripts  $f$  and  $s$  relate to the first and second subsample periods respectively)<sup>28</sup>.

A final point to note relates to the endogeneity/exogeneity of the model variables. In the complete theoretical model, we have three endogenous variables and seven exogenous variables. When we come to estimate the VECM to determine the number of cointegrating vectors ( $r$ ) in Section 7.2.4.2 below, no distinction is made between endogenous and exogenous variables<sup>29</sup> although when estimating the underlying VAR it is possible to make such a distinction. Thus it is contentious as to whether we should estimate the underlying VAR specifying  $\ln R(AAPR)$ ,  $R(r_m)$  and  $\ln ZLVF$  as endogenous variables and the remainder exogenous, or whether all variables should be considered endogenous. In the latter case, all variables (whether endogenous or exogenous) would be included in the vector  $y_t$  of equation (7.14) whereas in the former,  $y_t$  will be formed of only endogenous variables with a vector of current period exogenous variables ( $q_t$ ) additionally being included on the right hand side.

$$y_t = b_0 + b_1 t + \sum_{i=1}^p \Phi_i y_{t-i} + \Theta q_t + v_t \quad (7.15)$$

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<sup>27</sup> Multivariate techniques are particularly data intensive especially when the number of variables is large. For example, with eight variables, a constant and a time trend in each of the individual equations of the VAR, there are  $8(2 + 8p)$  parameters to estimate, where  $p$  is the number of lags in the underlying VAR. Thus the specification of a parsimonious model is a particularly important consideration in lag selection.

<sup>28</sup> There are other methods of choosing the optimal lag length to those presented in this section, one of which would be to examine the  $t$ -statistics of the individual equations of the VARs estimated. We could add lags to the VAR until the  $t$ -statistics of added lags in each equation become insignificant. However, given the number of variables in the underlying VAR and the number of equations estimated the output from such a procedure would be considerable. We therefore make use only of the more formal tests outlined in this section.

<sup>29</sup> See later for a discussion of this.

Here, the estimation of the underlying VAR for the complete model would involve the estimation of three equations. However, since these estimations would be subject to simultaneous equation bias, the preference instead is to estimate the VAR specification of equation (7.14); in addition, this is consistent with the estimation of a VECM (equation (7.13)) in which all variables are included in the vector  $y_t$ .

*The Akaike Information Criterion and the Schwartz Criterion*

Firstly, we may use the Akaike Information Criterion (AIC) or the Schwartz Criterion (SC) to determine the number of lags, although in practice these measures may lead to the selection of different lag lengths<sup>30</sup>. The results of these tests are shown in Table 7.2 below.

**Table 7.2 : AIC and SC Lag Selection Tests for the Underlying VAR based on  $T - 4$ ,  $T_f - 4$  and  $T_s$  Observations**

Sample	AIC	SC
1969Q1-1995Q4	4	2
1969Q1-1983Q4	4	4
1984Q1-1995Q4 <sup>31</sup>	3	1

The results indicate a lack of agreement between the AIC and SC criteria regarding the number of lags to be chosen for the underlying VAR for the whole period and the second subsample. For two of the three estimation periods, the SC suggests a lower lag length than that of the AIC, the former of which may be preferable due to the risk of over-parameterisation of the model. In addition, the closer correlation of the results of the SC test and the LM test (the latter of which is often considered the best measure) and the somewhat poorer performance of the AIC rule (as shown in Tables 7.1a through 7.1c) gives added weight to the use of the lag length suggested by the SC test.

<sup>30</sup> Calculation of the AIC and SC statistics is shown in equation (4.24) of Chapter 4.

<sup>31</sup> The maximum number of lags here is 3 (rather than 4) due to sample size restrictions.



### *The Likelihood Ratio Test*

A further procedure to determine the length of lag to be included in the underlying VAR relationship is that of the likelihood ratio (LR) test. This allows us to test the null hypothesis of independent restrictions on specified lag lengths of the underlying VAR and is essentially a test to guard against the over- or under-specification of the model by checking the joint significance of the included lags. It involves calculating the following LR test statistic

$$LR = 2[\ln(L_U) - \ln(L_R)] \sim \chi^2_{(0.05)}(m^2) \quad (7.16)$$

in which  $\ln(L_U)$  and  $\ln(L_R)$  are the system log likelihoods of the restricted and unrestricted models respectively. Under the null hypothesis that all of the parameter restrictions on any particular lag length in the VAR (of which there are  $m^2$ , where  $m$  is the number of equations in the VAR) hold, the LR statistic follows a  $\chi^2$  distribution with  $m^2$  degrees of freedom. The conventional way of undertaking the test is to choose a maximum number of lags (again, the same maximum lag length is chosen for the likelihood ratio test as is for the AIC and SC tests) and to calculate the statistic by restricting the model successively by one lag. For example, if we choose a maximum of 4 lags then the first statistic to be calculated will be  $LR(4:3) = 2[\ln(L_4) - \ln(L_3)]$  followed by  $LR(3:2) = 2[\ln(L_3) - \ln(L_2)]$  and so on until  $LR(1:0) = 2[\ln(L_1) - \ln(L_0)]$ . If the calculated test statistic is greater than the critical value of the  $\chi^2$  distribution at the 5 per cent level with  $m^2$  degrees of freedom then we may reject the null hypothesis but only when *all* of the test statistics below a certain lag are greater than the critical value of the  $\chi^2$  distribution. The results of these tests are shown in Table 7.3 below.

The likelihood ratio tests for the underlying VAR specification suggest that the maximum number of 4 lags be used for all sample periods.

**Table 7.3 : Likelihood Ratio Tests for the Number of Lags in the Underlying VAR based on  $T - 4$ ,  $T_f - 4$  and  $T_s$  Observations**

LR Statistic	1969Q1-1995Q4 Whole Sample	1969Q1-1983Q4 First Subsample	1984Q1-1995Q4 Second Subsample
$LR(4:3)$	230.0	695.8	N/A <sup>32</sup>
$LR(3:2)$	175.5	361.2	344.6
$LR(2:1)$	548.2	384.9	381.1
$LR(1:0)$	2621.8	1276.4	997.5
$\chi^2(100) = 124.34$ at 5 per cent significance			

### *Lagrange Multiplier Tests for Residual Serial Correlation*

It is important to check the residuals of the individual equations of the underlying VAR for possible serial correlation. The LM test as suggested by Breusch (1978) and Godfrey (1978) is used whereby the residual series from each individual equation in the VAR estimation is regressed on the original variables in the VAR and additionally  $\hat{u}_{t-1}, \dots, \hat{u}_{t-p}$  (the order  $p = 4$  is chosen due to the quarterly nature of the data). As suggested by Greene (1993), the statistic  $TR^2 \sim \chi^2(4)$  is calculated<sup>33</sup> based on the missing values for the lags of the residuals being set to zero rather than altering the estimation period to exclude such observations.

The results of the LM tests for each equation of the estimated system VAR are presented in Appendix 7.1 for lag lengths of between 1 and 4 inclusively. A calculated LM statistic which is greater than the critical value of the chi-squared distribution with 4 degrees of freedom (the critical values being 9.49 at the 5 per cent level, 11.14 at the 2.5 per cent level and 13.28 at the 1 per cent level of significance) implies that we may reject the null hypothesis of no serial correlation in favour of the alternative hypothesis that the equation contains serially correlated errors.

<sup>32</sup> In estimating the underlying VAR over the second subsample there are not enough observations to be able to select 4 lags, and thus the maximum lag length used (and the length suggested by the test) is 3. 'N/A' is used to indicate that there are insufficient degrees of freedom to estimate the model at a lag length of 4 in this and subsequent tables.

<sup>33</sup> This distribution is correct despite the fact the variables of the underlying model are non-stationary since the residuals being tested are assumed stationary.



Obviously, it would be favourable if the individual equations of the underlying VARs were found to contain serially independent errors, although it might be expected that undertaking a VAR system estimation on non-stationary  $I(1)$  series may not deliver this desirable property. This turns out to be the case, with the tables presented in Appendix 7.1 showing serially correlated errors in the majority of equations. Oddly, the serial correlation problem becomes no better as we add lags up to the fourth order suggesting that we should choose a relatively low number of lags in the VECM when testing for cointegration. The presence of serial correlation in some equations may indicate the fact that the dependent variables in question are not endogenous (and thus their behaviour should not be 'explained'). However, it must not be overlooked that the estimation of the VAR system is not the end product but rather a means to an end; it is estimated simply in order to suggest the optimal number of lags for the stationary VECM estimation. As such, although it is desirable for the errors of the VAR to be as serially independent as possible (and a lag structure should be chosen to reflect this) it will not be of major concern if some residual serial correlation remains in the system model.

#### *The Issue of Including a Time Trend in the underlying VAR*

Thus far we have assumed that the VAR model estimated to determine the optimal number of lags in the VECM specification contained both a constant and time trend. It may be reasonably assumed that we should always include a constant in the equations of the VAR, although the arguments for the inclusion of a time trend are not as compelling. Therefore it will be useful to undertake likelihood ratio tests in order to test zero restrictions on the deterministic trend coefficients. The statistic is calculated as in equation (7.16) above; if the calculated test statistic is greater than the critical value of the  $\chi^2$  distribution with  $m$  degrees of freedom (where  $m$  is the number of equations and also the total number of restrictions placed on the time trends) then we can reject the null hypothesis of the zero coefficient restrictions, i.e. we may conclude that the coefficients on the time trends in each VAR equation are not zero. The statistics are calculated for lag lengths of between 1 and 4 and are presented in Table 7.4 below.

**Table 7.4 : Likelihood Ratio Tests for the Inclusion of a Deterministic Time Trend in the Unrestricted VAR (Critical  $\chi^2(10) = 18.31$  at 95 per cent level)**

	Lags	LR Statistic
1969Q1-1995Q4	1	57.9539
	2	47.8303
	3	41.9691
	4	46.2891
1969Q1-1983Q4	1	44.3299
	2	85.2461
	3	76.7491
	4	86.8687
1984Q1-1995Q4	1	32.4741
	2	48.4618
	3	49.4976
	4	N/A

The results of Table 7.4 above unanimously indicate that we may reject the null hypothesis of zero restrictions on the coefficients on the time trend variable in the VAR system over all periods of estimation, implying that the underlying VAR should be estimated with both a constant and a time trend when identifying the optimal number of lags. This implies that in estimating the VECM of equation (7.13) we should include a constant in the specification (although not necessarily a time trend).

In conclusion to this section on lag selection, it is clear that there is a considerable lack of agreement between the various criteria we may use to determine the lag length in the underlying VAR specification. AIC and likelihood ratio tests for the number of lags would suggest the use of a relatively high number of lags whilst the SC and LM tests imply the use of a more parsimonious lag structure. Given the divergence of the results presented above, it would be imprudent to state a preferred exact lag length choice for each sample period. However, the desire to choose as parsimonious a model as possible both to allow sufficient degrees of freedom for the estimations to be valid and also for tractability of the VECM is consistent with the results of the SC and LM tests, and as such it is decided to opt for a relatively low lag length structure of 2 in all estimations. However, we will see later in Section 7.2.8 that when we come to estimate the error correction representations practicalities prevent us from using the same number of lags for all exogenous variables.



#### 7.2.4.2 Step 2 : Testing for Cointegration

For the complete set of non-stationary  $I(1)$  variables we may test for the existence of  $r$  cointegrating vectors in the model, which is given in equation (7.13) by the rank of the matrix  $\Pi$ . Obviously, if we were to find that  $r = 0$  then we may conclude that the model is neither one of error correction nor of cointegration, but rather simply a VAR in first differences. The test results for the number of cointegrating vectors are presented in this section based on Johansen's (1988, 1991) eigenvalue (EV) and trace (TR) tests. Johansen's EV test involves estimating the rank of the matrix  $\Pi$  which is found by determining the number of non-zero characteristic roots (or eigenvalues) of a certain related matrix. The test is undertaken by calculating a likelihood ratio statistic using the estimated values of the characteristic roots. Although the statistic has a non-standard distribution, most time series statistical packages calculate and report the appropriate critical values with which we can test the null hypothesis that there are at most  $r$  cointegrating vectors. The two tests tend (EV and TR) to yield ambiguous results in practice.

In the following analysis, the VECM equations as defined in (7.13) are estimated without trends; as noted previously, the specification of the underlying VAR with a deterministic time trend implies simply that we must have an intercept term in the VECM but not necessarily a time trend. However, the way in which we specify the intercept term in the VECM will have important implications for the specification of the long run cointegrating relationships. If, when estimating the VECM, we wish to be able to identify a constant term in the long run cointegrating relationships of the matrix  $\Pi$  (which we will, since the long run cointegrating vector will be used to identify periods of excess mortgage demand later in the chapter, and the long run equations may be misspecified without the inclusion of a constant term) then it is necessary to restrict the constant  $a_0$  in equation (7.13). If we were to estimate the VECM with an unrestricted intercept term it would be impossible to separate the portion of the estimated constant which is attributable to the VECM and that which is attributable to the long run cointegrating relationship itself.

Table 7.5 below indicates the number of cointegrating relations observed for various lag lengths (the optimal lag length being chosen in the previous section). Figures in bold type indicate the number of cointegrating vectors at the 5 per cent level of significance and those in normal type at the 10 per cent level.

**Table 7.5 : The Number of Cointegrating Vectors Detected Among All Variables of the Complete Model of Mortgage Supply and Demand**

*1969Q1-1995Q4 (full sample)*

Lags in VAR	Number of Cointegrating Vectors			
	EV Test		TRACE Test	
1	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>
2	<b>2</b>	<b>2</b>	<b>4</b>	<b>5</b>
3	<b>2</b>	<b>2</b>	<b>6</b>	<b>6</b>
4	<b>6</b>	<b>6</b>	<b>6</b>	<b>9</b>

*1969Q1-1983Q4 (first subsample)*

Lags in VAR	Number of Cointegrating Vectors			
	EV Test		TRACE Test	
1	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>
2	<b>2</b>	<b>2</b>	<b>7</b>	<b>8</b>
3	<b>7</b>	<b>10</b>	<b>9</b>	<b>10</b>
4	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>

*1984Q1-1995Q4 (second subsample)*

Lags in VAR	Number of Cointegrating Vectors			
	EV Test		TRACE Test	
1	<b>3</b>	<b>3</b>	<b>4</b>	<b>5</b>
2	<b>6</b>	<b>6</b>	<b>9</b>	<b>9</b>
3	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>
4	N/A	N/A	N/A	N/A

Recent research by Pesaran and Shin (1995) and Pesaran *et al* (1996a, 1996b) allows us to differentiate between those variables in the VECM that are endogenous and those that are exogenous. However, since this research is still in its infancy and there has been little criticism of the techniques used, all variables are considered to be endogenous in the analysis presented here<sup>34</sup>.

<sup>34</sup> In addition, the only package explicitly allowing for the specification of *I*(1) exogenous variables in the cointegrating relationships is Microfit Version 4.0 (developed by Pesaran and Pesaran (1997)). However, the number of exogenous variables permitted by this software is limited to five, two less than the number in the mortgage model of this chapter.



It is clear from the results above that the suggested number of cointegrating vectors varies considerably with the period of estimation, the type of test undertaken (EV or TR), the number of lags used in the VECM when carrying out the test and the level of significance of the test. It can be seen that the number of cointegrating vectors increases as the sample size is reduced. This may be attributable to the fact that over a shorter time period it is easier to find a long run cointegrating relationship amongst a set of variables than over a longer sample period. If the sample is large, it is more likely that structural changes to the model will have occurred (which is especially true in relation to the model considered in this chapter due to changes in the nature of the mortgage market over the whole estimation period) making it more difficult to find a cointegrating vector that will satisfy the whole period.

In Step 1 (Section 7.2.4.1) it was determined that the appropriate number of lags to be included in the underlying VAR was 2 for all periods. Thus at the 5 per cent significance level the eigenvalue test suggests that there are two cointegrating vectors for the whole sample and the first subsample and six for the second subsample, whereas the trace test suggests the existence of four cointegrating vectors for the whole sample, seven for the first subsample and nine for the second. Since the eigenvalue test is probably more often used in empirical studies than the trace test, we concentrate here on the number of cointegrating vectors as suggested by the former. The *a priori* expectation is that we would hope to find at least three cointegrating relationships among the complete set of variables, representing functions for the determination of the equilibrium quantity of mortgages traded, the mortgage interest rate and the loan to value ratio<sup>35</sup>. In the second subsample period a sufficient number of cointegrating relations are found to support this contention. However, in the first subsample period only two cointegrating vectors are found. This is not unexpected, since during the 1970s and early 1980s, mortgage lending institutions used both the mortgage interest rate and the loan to value ratio in tandem to restrict the quantity of

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<sup>35</sup> To be completely rigorous, the Johansen test is also used to determine the number of cointegrating vectors amongst each set of reduced form variables separately. The conclusions drawn are consistent with those presented for the complete model in the main text, namely that *at least* (and often substantially more than) one cointegrating vector can be supported by each set of reduced form variables. However, the output from this procedure is lengthy (as all the results presented here for the complete set of model variables are derived for an additional three sets of variables representing the individual reduced form relationships) and thus is not presented here.



mortgage loans traded. This may in turn imply that we might not expect to find linearly independent long run reduced form vectors for *both* the interest rate and loan to value ratio; rather they would have been set as a single 'price vector'. The situation has been different following the move towards a competitive market in the mortgage finance industry in the early 1980s. In the absence of disequilibrium mortgage rationing, the loan to value ratio has become less constrained to be set at the discretion of the mortgage lender *independently* of the mortgage interest rate<sup>36</sup>, thus implying the possibility of detecting of a greater number of cointegrating vectors.

Given that only three relations were expected to emerge from this set of variables, the high number of cointegrating vectors that were detected in the second subsample was surprising. This may reflect the presence of other long run relationships in the system, for example the household's budget constraint and other constraints faced by households and mortgage lenders.

## 7.2.5 Long Run Cointegrating Equation Results

### 7.2.5.1 Ordinary Least Squares (OLS) Results

The following tables present the OLS results for the long run reduced form equations determining the equilibrium quantity of mortgages traded, the mortgage rate and the loan to value ratio. We should stress that if OLS had been used (or indeed any other single equation technique) to estimate the structural models of demand and supply it is likely that we would have observed the reduced form parameters rather than structural estimates<sup>37</sup>; specifically, using OLS to estimate the structural relationships would have had the effect of incorporating supply effects in the demand equation and vice versa. Rather, multivariate techniques (such as Johansen's maximum likelihood approach) should be used in order to tease out the individual structural relationships. However, poor results were obtained from the Johansen estimations (we were unable to observe

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<sup>36</sup> This relates to the discussion in Section 7.1.4 on the complementarity and substitutability of the mortgage interest rate and the loan to value ratio.

<sup>37</sup> They would not have been the true reduced form coefficients since the structural models contain both exogenous and endogenous independent variables.



clearly the individual structural supply or demand relationships) and essentially this is the motivation for explicitly specifying and estimating the reduced form model.

Given that all of the variables are  $I(1)$  and that there exists at least one cointegrating relationship for each reduced form equation, the OLS point estimators of these relationships will be super-consistent. However, although the standard  $t$ -statistics are presented in parentheses in Tables 7.6a through 7.6c, they will not be valid when the variables are non-stationary. This is a considerable drawback of the OLS procedure, undermining any statistical inference as to the significance of the estimated coefficients. The motive for including the OLS results here is that in the search for an estimator which can deliver consistent coefficient estimators with valid standard errors, it is reasonable to choose that estimator which yields coefficients most similar in size to those of the super-consistent OLS results<sup>38</sup>.

**Table 7.6a : OLS Estimates : The Reduced Form Mortgage Equation**  
Dependent Variable :  $\ln R(AAPR)$

Explanatory Variable	1969Q1-1995Q4	1969Q1-1983Q4	1984Q1-1995Q4
Constant	-16.4101 (-4.78)	-16.5102 (-2.88)	1.0988 (0.12)
$\ln COLLAT$	0.9637 (2.96)	-0.3871 (-0.53)	0.8832 (1.39)
$\ln R(AAAU)$	-0.1791 (-1.83)	0.1250 (0.63)	-0.7445 (-4.03)
$\ln R(PAHM)$	0.7169 (4.18)	0.7017 (2.69)	0.6576 (2.11)
$\ln R(ALDO)$	1.4149 (6.68)	1.7547 (4.56)	0.5225 (1.19)
$\ln INFL$	-0.2789 (-4.08)	-0.0658 (-0.42)	-0.0612 (-0.59)
$R(UC)$	-0.0419 (-4.60)	-0.0362 (-2.72)	-0.0109 (-0.70)
$\ln MIRAS$	0.9516 (9.38)	1.2610 (2.97)	0.3668 (2.67)
No. Obs.	108	60	48
$R^2$	0.8719	0.6864	0.9193
Adjusted $R^2$	0.8629	0.6442	0.9052
DW-Statistic	0.5315	0.3753	1.2705

*t*-statistics in parentheses

<sup>38</sup> The size and signing of the OLS coefficient estimates are not examined here. Discussion of the long run parameter estimates of the reduced forms is reserved for later estimations undertaken using Park's (1992) methodology in which the standard errors are valid. The OLS coefficients are presented here purely for purposes of comparison.

**Table 7.6b : OLS Estimates : The Reduced Form Mortgage Interest Rate Equation**

Dependent Variable :  $R(r_m)$

Explanatory Variable	1969Q1-1995Q4	1969Q1-1983Q4	1984Q1-1995Q4
Constant	-76.4074 (-3.06)	-160.2541 (-5.72)	-174.0332 (-3.26)
$\ln COLLAT$	4.8339 (2.04)	16.1783 (4.53)	10.0709 (2.67)
$\ln R(AAAU)$	-1.0037 (-1.40)	-0.2286 (-0.23)	2.1156 (1.93)
$\ln R(PAHM)$	2.1024 (1.68)	0.7560 (0.59)	4.5823 (2.48)
$\ln R(ALDO)$	5.0658 (3.28)	6.6517 (3.54)	7.0298 (2.69)
$\ln INFL$	-6.7484 (-13.55)	-7.6638 (-10.01)	-3.8805 (-6.32)
$R(UC)$	0.3226 (4.86)	0.3251 (5.01)	0.2313 (2.51)
$\ln MIRAS$	4.7400 (6.41)	-3.6494 (-1.76)	4.3513 (5.34)
No. Obs.	108	60	48
$R^2$	0.9086	0.9354	0.7524
Adjusted $R^2$	0.9022	0.9267	0.7091
DW-Statistic	0.3475	0.6547	0.9521

*t*-statistics in parentheses

**Table 7.6c : OLS Estimates : The Reduced Form Loan to Value Ratio Equation**

Dependent Variable :  $\ln ZLVF$

Explanatory Variable	1969Q1-1995Q4	1969Q1-1983Q4	1984Q1-1995Q4
Constant	2.2548 (4.43)	3.4171 (4.58)	1.4032 (1.06)
$\ln COLLAT$	0.0848 (1.76)	-0.1691 (-1.78)	0.3329 (3.55)
$\ln R(AAAU)$	-0.0154 (-1.06)	-0.0032 (-0.13)	-0.0314 (-1.15)
$\ln R(PAHM)$	-0.1237 (-4.86)	-0.0976 (-2.87)	-0.0817 (-1.78)
$\ln R(ALDO)$	0.1809 (5.76)	0.1880 (3.76)	0.1377 (2.12)
$\ln INFL$	-0.0401 (-3.95)	-0.0600 (-2.94)	0.0165 (1.08)
$R(UC)$	-0.0010 (-0.72)	-0.0027 (-1.59)	-0.0004 (-0.15)
$\ln MIRAS$	0.0496 (3.30)	0.2336 (4.24)	-0.0595 (-2.94)
No. Obs.	108	60	48
$R^2$	0.7134	0.7032	0.4950
Adjusted $R^2$	0.6934	0.6633	0.4066
DW-Statistic	0.2840	0.3075	0.3462

*t*-statistics in parentheses



As a result of the hypothesised existence of disequilibrium mortgage rationing in the first sample period it may be the case that the only reduced form equations which are not misspecified are those estimated over the period 1984Q1 to 1995Q4. This conjecture can be checked by considering both the goodness of fit measures and the Durbin-Watson (DW) statistics of each regression<sup>39</sup>. In the OLS estimation of the reduced form mortgage equation presented in Table 7.6a, the DW statistics suggest that serial correlation of the residuals constitutes a greater problem in the model estimated over the first sample period than that of the second subsample. In addition, the  $R^2$  and adjusted  $R^2$  measures are higher for the second sample period than either the first subsample or whole sample periods. This would tend to point to the misspecification of the reduced form mortgage equation when estimated during periods of disequilibrium rationing. As such, any results based on estimations undertaken using a data set which includes the first subsample period must be interpreted with care.

However, the same cannot be said of the reduced forms for the mortgage interest rate and the loan to value ratio. In the former, although for the second period estimation the DW statistic is higher, the  $R^2$  measures are lower, and in the latter neither the DW statistic nor the coefficient of determination can offer evidence to suggest that the second period estimation is more appropriately specified. However, although it is clear that the amount of mortgages traded will depend on the degree of disequilibrium mortgage rationing, it is by no means obvious *ex ante* how (or even *if*) either the mortgage interest rate or loan to value ratio will respond to such mortgage rationing. Thus it could possibly have been expected that intertemporal comparisons of the DW or  $R^2$  statistics for these equations would be fruitless.

#### 7.2.5.2 Park's (1992) Canonical Cointegrating Regression Technique (CCR) Results

Park's (1992) non-parametric CCR technique for estimating long run cointegrating relationships between a set of first order non-stationary variables is found to provide parameter estimates most accurately matching those estimated by the OLS procedure.

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<sup>39</sup> Despite the fact that the models contain non-stationary variables, these statistics are valid because the equations are cointegrated and the residuals stationary.

As pointed out in Chapter 4, a further reason for favouring its use here is that it has been proven to provide econometrically superior results, specifically in the form of more efficient estimators.

To recapitulate briefly, Park's procedure transforms the non-stationary  $I(1)$  processes of the cointegrating model by making use of the model's stationary components such that the inefficiency of the OLS procedure in estimating the long run model is removed. Section 4.3.2.1 of Chapter 4 discusses this technique in more detail. Tables 7.7a to 7.7c below present the long run estimation results based on this procedure.

Since this chapter is interested in explaining how the equilibrium level of mortgages per period is determined, the main focus of this section is the reduced form mortgage equation of Table 7.7a. There will, nevertheless, be an analysis of the results from the reduced form mortgage interest rate and loan to value ratio estimations albeit in lesser detail.

**Table 7.7a : Park's CCR Estimates : Reduced Form Mortgage Equation**  
Dependent Variable :  $\ln R(AAPR)$

Explanatory Variable	1969Q1-1995Q4	1969Q1-1983Q4	1984Q1-1995Q4
Constant	-14.3305 (-2.71)	-9.9864 (-1.80)	-13.3542 (-2.14)
$\ln COLLAT$	0.8823 (2.12)	0.3944 (0.78)	1.9398 (4.65)
$\ln R(AAAU)$	-0.1755 (-1.25)	-0.5122 (-2.55)	-0.6683 (-6.16)
$\ln R(PAHM)$	0.8783 (3.09)	1.3357 (5.14)	0.9457 (6.02)
$\ln R(ALDO)$	1.2577 (3.37)	1.2250 (3.02)	1.0515 (3.57)
$\ln INFL$	-0.3980 (-3.53)	-0.3616 (-3.66)	-0.2573 (-3.66)
$R(UC)$	-0.0642 (-2.99)	-0.0474 (-2.90)	-0.0312 (-2.57)
$\ln MIRAS$	1.0392 (6.05)	1.8558 (8.24)	0.4140 (6.70)
No. Obs.	108	60	48
<i>t</i> -statistics in parentheses			



**Table 7.7b : Park's CCR Estimates : Reduced Form Mortgage Interest Rate Equation**

Dependent Variable :  $R(r_m)$

Explanatory Variable	1969Q1-1995Q4	1969Q1-1983Q4	1984Q1-1995Q4
Constant	-110.9353 (-2.26)	-160.7143 (-7.21)	-372.2512 (-7.55)
$\ln COLLAT$	5.2833 (1.31)	16.1005 (7.24)	23.5127 (7.51)
$\ln R(AAAU)$	-0.4986 (-0.37)	0.1332 (0.15)	4.1545 (4.36)
$\ln R(PAHM)$	-2.0552 (-0.77)	0.5664 (0.65)	7.4523 (5.69)
$\ln R(ALDO)$	8.4598 (2.54)	6.6231 (4.20)	14.2839 (5.90)
$\ln INFL$	-7.2478 (-5.92)	-8.1182 (-17.76)	-5.6595 (-9.87)
$R(UC)$	-0.1842 (-0.68)	0.2982 (3.53)	0.0072 (0.07)
$\ln MIRAS$	6.6490 (4.11)	-2.9510 (-3.36)	4.7720 (8.11)
No. Obs.	108	60	48

*t*-statistics in parentheses

**Table 7.7c : Park's CCR Estimates : Reduced Form Loan to Value Ratio Equation**

Dependent Variable :  $\ln ZLVF$

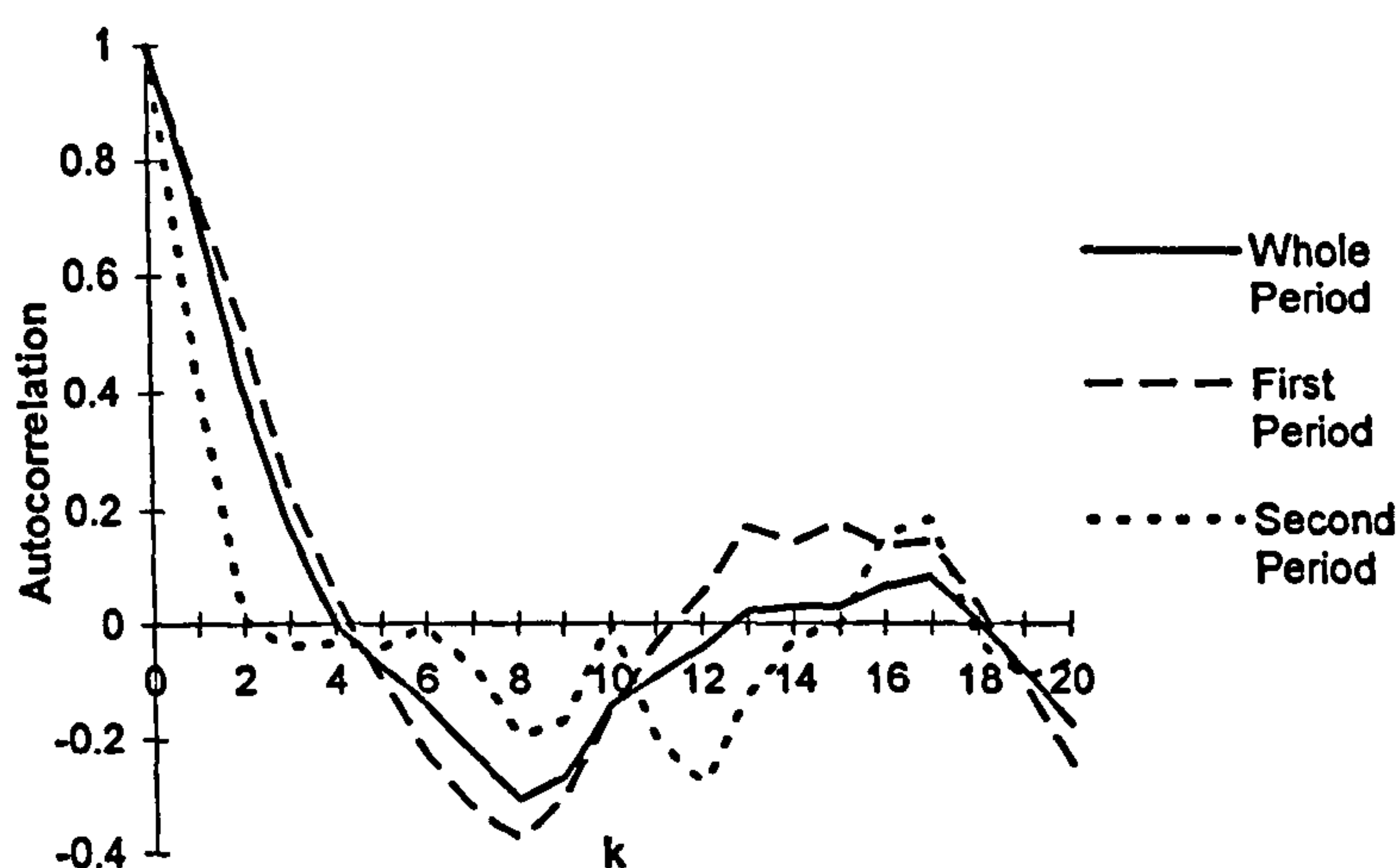
Explanatory Variable	1969Q1-1995Q4	1969Q1-1983Q4	1984Q1-1995Q4
Constant	0.9445 (0.79)	4.8877 (4.08)	-0.6797 (-0.29)
$\ln COLLAT$	0.1594 (1.70)	0.0284 (0.28)	0.5006 (3.30)
$\ln R(AAAU)$	-0.0310 (-0.98)	-0.1421 (-3.14)	0.0408 (0.84)
$\ln R(PAHM)$	-0.1553 (-2.69)	-0.0109 (-0.18)	0.0930 (1.21)
$\ln R(ALDO)$	0.2718 (3.30)	0.0689 (0.79)	0.1321 (1.03)
$\ln INFL$	-0.0521 (-2.08)	-0.1056 (-4.93)	-0.0578 (-1.68)
$R(UC)$	-0.0031 (-0.69)	-0.0043 (-1.24)	-0.0116 (-2.10)
$\ln MIRAS$	0.0903 (2.51)	0.3149 (6.47)	0.0061 (0.18)
No. Obs.	108	60	48

*t*-statistics in parentheses

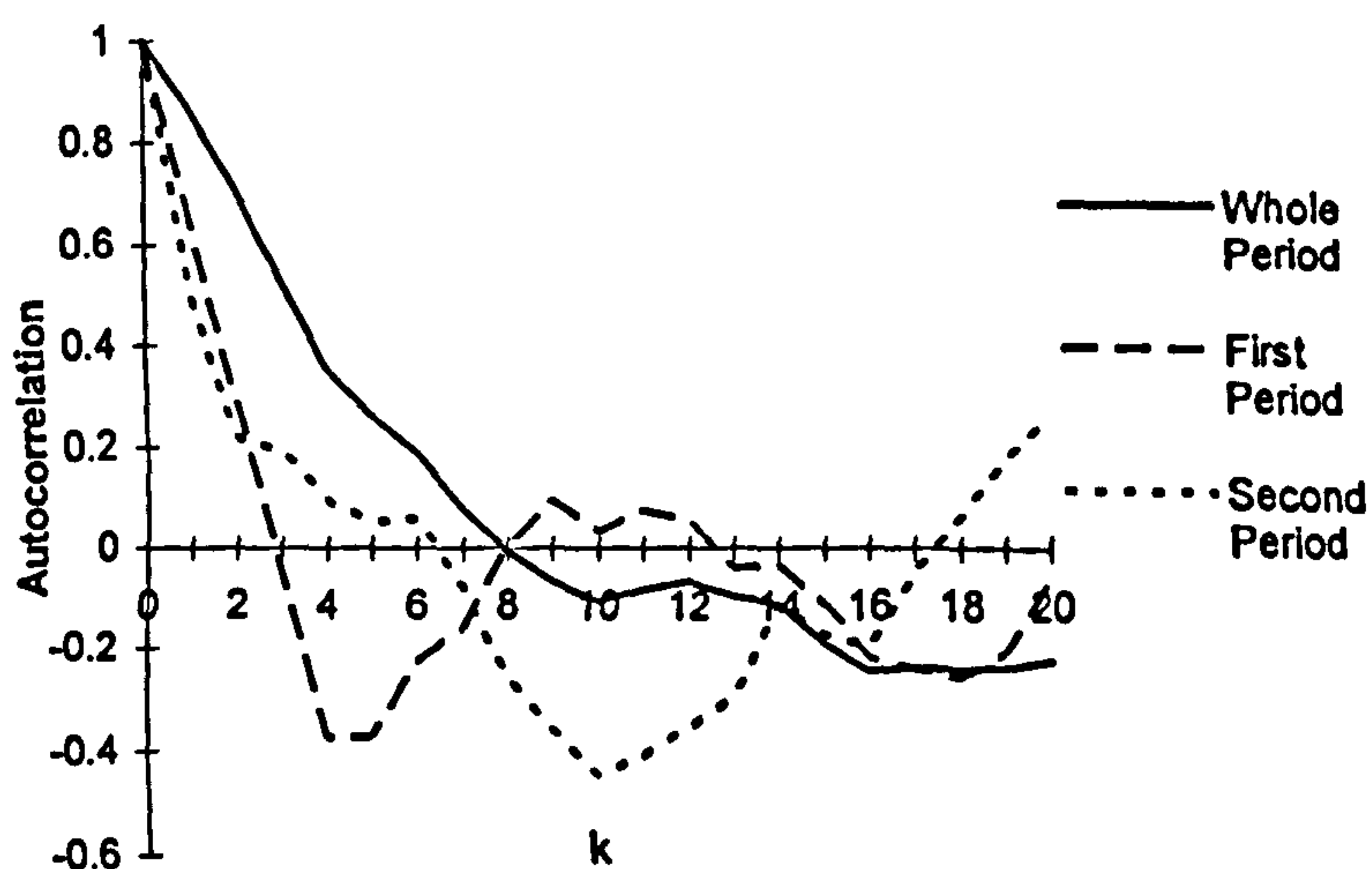
It is particularly important to check that the estimations presented in Tables 7.7a through 7.7c are indeed cointegrating relations. This can be done by checking for the stationarity of the residuals from each regression; stationarity of the residual series

would imply that there is a long run cointegrating relationship among the set of variables. To test for stationarity, the autocorrelation functions for the residual series are plotted and presented in Figures 7.5 to 7.7 below<sup>40</sup>.

**Figure 7.5 : Autocorrelation Function for the Residuals of Park's Estimation of the Reduced Form Mortgage Equation**



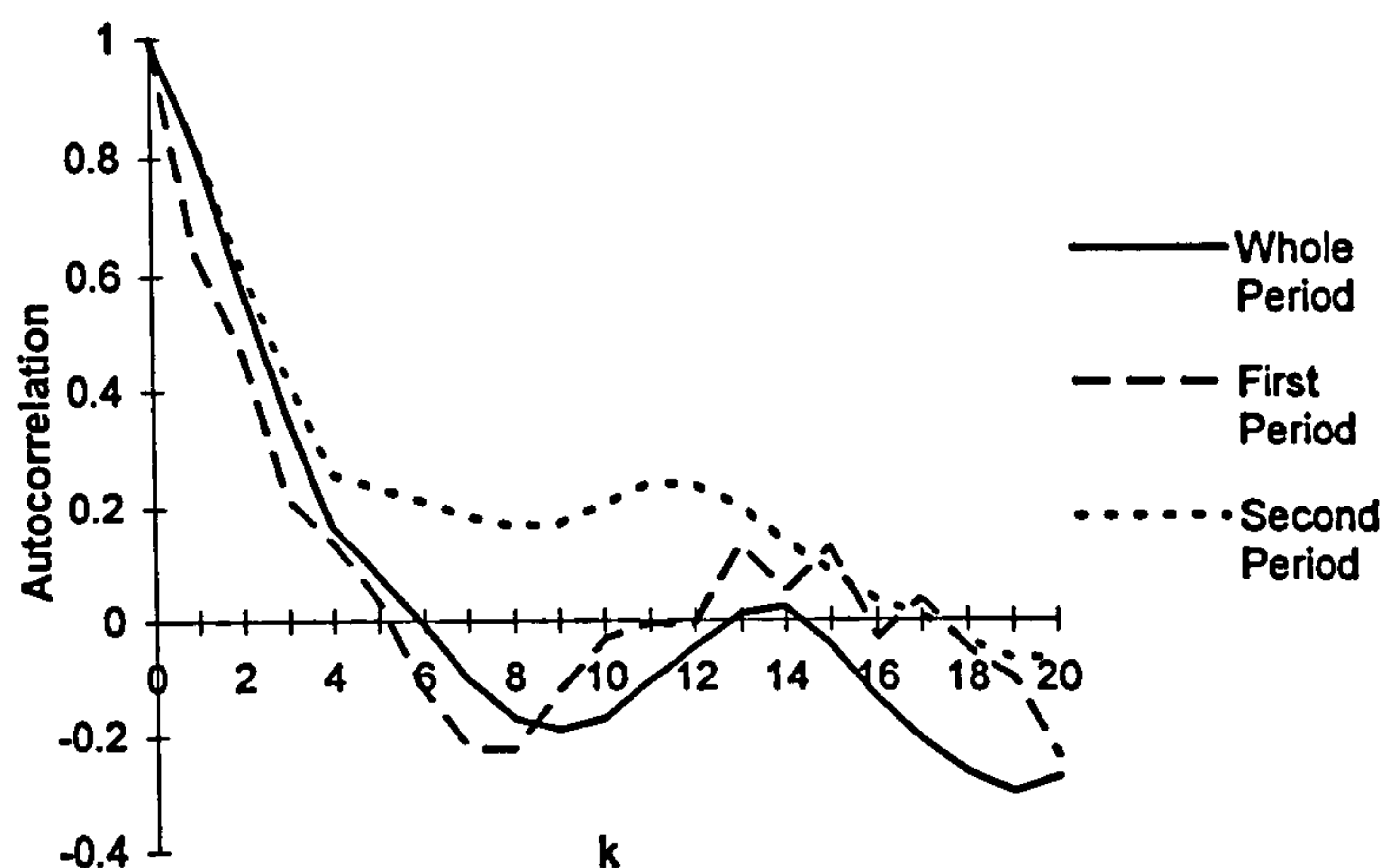
**Figure 7.6 : Autocorrelation Function for the Residuals of Park's Estimation of the Reduced Form Mortgage Interest Rate Equation**



<sup>40</sup> It should be noted that it is not possible to test for residual stationarity using ADF tests since we do not know the underlying distribution of the residuals generated by Park's (1992) CCR technique. As such we do not know the critical values against which hypotheses of non-stationarity should be tested.



**Figure 7.7 : Autocorrelation Function for the Residuals of Park's Estimation of the Reduced Form Loan to Value Ratio Equation**



For all three equations and estimation periods, the autocorrelation function drops off quickly to zero as the number of lags ( $k$ ) increases, indicating that the residual series are stationary.

The similarity of the parameters estimated by Park's methodology and OLS is particularly striking. Over 83 per cent of all parameters estimated using the CCR technique possess the same sign as those of the OLS procedure. The reduced form loan to value ratio equation exhibits the greatest number of sign differences between the two procedures. Additionally, the signing of the coefficients in the equations estimated using Park's procedure was fairly stable across all three estimation periods, with none of the seven variable coefficients in the reduced form mortgage equation changing sign between the three sample periods, two out of the seven in the loan to value ratio equation and four in the mortgage rate equation. However, this provides little indication of parameter stability over time, an issue which will be addressed later in the chapter (see Section 7.2.6).

The *a priori* expected signs of coefficients in the reduced form mortgage equation are given in Table 7.8 below. However, in the interpretation of the results below, one

must be careful in making any inferences about the structural parameters based solely on the coefficient estimates of the reduced form.

**Table 7.8 : *A Priori* Expected Signs for Reduced Form Mortgage Equation Coefficients**

Variable	Expected Sign
$\ln COLLAT$	+
$\ln R(AAAU)$	+
$\ln R(PAHM)$	-/+
$\ln R(ALDO)$	-/+
$\ln INFL$	-/+
$R(UC)$	-
$\ln MIRAS$	+

In the reduced form mortgage equation the signs of the coefficients on the collateral variable are positive as anticipated, with a higher value of dwelling stock per pound of mortgage loan outstanding (and thus lower credit or default risk) associated with increased desired mortgage supply. The coefficient is insignificant between 1969Q1 and 1983Q4 but becomes higher and significant in the second subsample (1984Q1 to 1995Q4), a phenomenon for which there is a possible explanation. Building societies, being almost the sole suppliers of private mortgage lending during the 1970s, were forced to ration mortgages as savings to fund their business were being misallocated to banks and other private financial institutions which were barred from lending in the mortgage market. As such, it was the availability of funds that restricted building society lending. During the 1980s and 1990s, mortgage lending has essentially become demand-determined, with the result that lenders (who have become almost entirely unrestricted by fund availability) now constrain their lending in response to other factors such as risk considerations.

The evidence on the total per period savings measure ( $\ln R(AAAU)$ ) across all samples is that it is negatively related to the level of mortgages traded, becoming more significant in the second subsample. Since savings were included as a supply variable in the reduced form this result contrasts with the expectation that a higher level of savings should allow mortgage lenders to increase supply. Indeed, the negative coefficients on this variable may possibly be capturing a demand effect, with a higher



level of savings allowing mortgage borrowers to afford a greater downpayment on a house and thus require a lower mortgage. Another plausible explanation for the negative coefficient on this variable is that in periods of low demand for housing (and thus also mortgages), households will tend to accumulate savings which will be spent on mortgage repayments or downpayments in times of a housing and mortgage market boom.

We may interpret the consistently positive and significant coefficients on the house price variable in two ways. The first implication is that as real house prices rise, a larger real mortgage loan is required in order to purchase a house of the same size yielding the same level of housing services. This finding is therefore consistent with the theoretical predictions of Jones' (1993) model (see equation (6.4) of Chapter 6). Secondly, the positive coefficient may also suggest that the investment motive for holding a property is important in encouraging mortgage lending *over and above* the effect captured by expected future house price changes in the real user cost variable.

From Table 7.7a it may be seen that the effect of financial wealth on the equilibrium level of mortgages traded per period is clearly positive and enjoys a reasonable and intertemporally constant level of significance. A positive coefficient indicates that the standard wealth effect prevails, whereas a negative coefficient would suggest the importance of financial wealth as a substitute for mortgage borrowing. As we discussed in Section 6.2.2 of Chapter 6, Jones' (1993) theoretically derived mortgage demand function would suggest that the coefficient on the financial wealth variable will be higher for estimations during the 1970s given that for much of the period the real mortgage interest rate was lower than the real rate of return on financial wealth, reducing the desire to substitute financial wealth for mortgage debt (see equation (6.4) of Section 6.2.2). This theory is confirmed by the results presented in Table 7.7a, with the coefficient on the log of financial wealth in the reduced form mortgage equation decreasing from 1.23 during the first subsample period to 1.05 in the second. Further, since we can interpret the coefficient on the real wealth variable as an elasticity, we observe that there has been a reduction in the real wealth elasticity of mortgage demand between the first subsample and the second. This implies that mortgages



have become less of a 'luxury good' between the first and second sample periods, a reasonable conclusion in the light of the changes in both home ownership and mortgage provision between the two periods<sup>41</sup>.

The rate of inflation has a negative and significant effect on real mortgage demand during all estimation periods as one would expect given its power to tilt the stream of real mortgage repayments towards the beginning of the loan. The higher is the rate of inflation, the greater will be the burden of initial real mortgage repayments for any given level of nominal mortgage debt, and thus the lower the demand for mortgages. The fact that the coefficient on inflation is fairly small suggests that there may be an offsetting positive effect of inflation (primarily reflecting the desire to invest in housing as a hedge against inflation and for tax purposes<sup>42</sup>) on the underlying demand for housing working against the negative impact caused by financial constraints. A slightly higher coefficient (in absolute terms) in the first subsample period than in the second may suggest that the stickiness of mortgage interest rates during the period served as a disincentive for mortgage lenders to on-lend funds when inflation was high and rising.

The coefficient on the variable representing the real user cost of owner occupation is, as expected, negative and significant in all three sample periods. A rise in the real user cost of housing capital serves to detract potential owner occupiers from purchasing real estate and thereby reduces mortgage demand. The finding of consistently negative coefficients in the reduced form mortgage equation across each estimation period helps in validating the construction of the real user cost and its component parts (most notably the ARMA model determining expected house price movements presented in the previous chapter). Finally, the coefficient on mortgage tax relief as a percentage of the value of outstanding mortgages is positive and highly significant, indicating that the effective percentage at which MIRAS is deductible is important in shaping the demand for mortgage finance. The significant decline in the

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<sup>41</sup> Nevertheless, this conclusion is very tentative given that in all three sample periods it is not possible to reject the null hypothesis at all reasonable levels of significance that the coefficient on real financial wealth is unity.

<sup>42</sup> See Section 3.3.2 of Chapter 3 for a more in depth discussion of the tax advantages of holding housing assets when inflation is high.



size of the coefficient between the first and second subsample periods indicates the reduction in importance of MIRAS over the last three decades as government policy has slowly eroded the financial benefits of the scheme to mortgage borrowers.

The results from the reduced form mortgage interest rate equation are presented in Table 7.7b above. The  $t$ -statistics in general are substantially higher for the subsample periods than they are for the whole period, although as previously mentioned this is not unusual given the regime shift expected. In fact this is also the case (albeit to a lesser extent) in the mortgage and loan to value ratio equations and is consistent with the correct identification of the date of the structural break in the market.

The coefficient on  $\ln COLLAT$  (the measure of risk in the structural supply function) in the reduced form mortgage interest rate equation is positive for all three estimation periods and highly significant in the subsample periods. One may have expected this coefficient to possess a negative sign since an increase in the amount of housing collateral per pound of outstanding mortgage debt could be considered a reduction in the lender's risk thus stimulating mortgage supply. However, what the variable is most probably capturing is an intertemporal adjustment effect. Given that on the demand side there exists an optimal or desired level of mortgage debt as a proportion of the total value of the housing stock, during those periods in which this proportion is low we would expect to see a positive stock adjustment of mortgage debt to re-attain the long run desired proportion. This would tend to imply that when the variable  $\ln COLLAT$  is high we may expect to see an increase in mortgage demand and a subsequent increase in the mortgage rate of interest. This would also explain the positive coefficient in the reduced form mortgage equation of Table 7.7a.

The coefficient on the measure of savings is negative in the whole sample and positive in both subsamples, but only significant in the second period estimation. Although it may initially be expected that a higher level of savings would exert a positive influence on supply (and thus lower the interest rate), it was pointed out in the discussion of the results in Table 7.7a that a rise in household savings could occur at the expense of mortgage borrowing as households typically increase their savings in



order to fund a future downpayment on a dwelling. Both explanations imply that a higher level of savings is associated with a lower equilibrium mortgage rate<sup>43</sup>, although this is not borne out by the reduced form estimates. A possible reason for the observed positive coefficients in the two subsample periods is one of reversed causality : a higher mortgage rate has the effect of encouraging potential borrowers to save rather than spend their savings on downpayments. In reality, there are undoubtedly a multitude of behavioural links between savings and the mortgage rate, possibly offsetting each other and thus pulling the coefficient in opposite directions.

In both subsample periods the results indicate that higher real house prices and financial wealth or lower inflation will stimulate mortgage demand and therefore lead to a higher real equilibrium rate of interest. A rise in MIRAS benefits is also shown to lead to an increase in mortgage rates in the second subsample estimation, again a result of demand side influences. The signing of the coefficients on the log of real savings, the log of real house prices and the real user cost diverge in the full sample from that of the subsample period estimations, although the coefficients are insignificant in the former.

The results from the estimated cointegrating reduced form equation for the loan to value ratio in Table 7.7c should be able to shed some light on the way in which the mortgage interest rate and loan to value ratio interact with each other, i.e. whether they are complementary to or substitutes for one another. Recall that substitutability implies that a loosening of the non-interest mortgage loan terms (i.e. an increase in  $\ln ZLVF$ ) will be accompanied by an increase in the mortgage rate of interest whereas the complementarity argument suggests that a loosening of the loan to value ratio would be indicative of a general easing of mortgage credit availability and thus a fall in the mortgage interest rate. Thus if the mortgage interest rate and the loan to value ratio move together in the same direction following a change in one of the exogenous variables of the model we would argue that the two are substitutes whereas if they were to move in opposite directions they could be considered complements. Table 7.9

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<sup>43</sup> In addition, with a greater amount of savings, *ceteris paribus*, the rate of interest paid on retail deposits should fall as mortgage lenders will have a greater amount of retail funds at their disposal. Then if the mortgage rate is simply a mark-up on the deposit rate the former should fall also.



below shows for each of the three sample periods whether we observe substitutability between the interest and non-interest terms of the mortgage contract (denoted by a ‘+’ indicating that a change in the relevant exogenous variable leads to a movement in the same direction of both the mortgage interest rate and loan to value ratio) or complementarity between the two (denoted by a ‘–’ sign).

**Table 7.9 : Complementarity and Substitutability Between the Mortgage Interest Rate and the Loan to Value Ratio**

Variable	1969Q1- 1995Q4	1969Q1- 1983Q4	1984Q1- 1995Q4
lnCOLLAT	+	+	+
lnR(AAAU)	+	-	+
lnR(PAHM)	+	-	+
lnR(ALDO)	+	+	+
lnINFL	+	+	+
R(UC)	+	-	-
lnMIRAS	+	-	+

It is clear that from the table that there has been a change in how mortgage lenders perceive the interaction between the mortgage interest rate and loan to value ratio between the two estimation periods<sup>44</sup>. During the first subsample, the changes in four out of the seven exogenous variables led to changes in opposing directions of the mortgage interest rate and the loan to value ratio. This general complementarity of the two mortgage terms suggests that in times when credit became tight, mortgage lenders reduced the loan to value ratio in order to reinforce a higher interest rate so as to ration mortgage demand out of the market (in an equilibrium sense). However, by the second period of estimation the situation had changed considerably. Six of the seven interaction signs of Table 7.9 suggest that it is the substitution argument that dominates, implying that the loan to value ratio is seen as an *alternative* to the mortgage interest rate in restricting mortgage lending. The reason for this is that in the second subsample estimation it is postulated that disequilibrium rationing was non-existent; as such, increases in the mortgage interest rate tended to be the result of base rate rises rather than as a means to stave off mortgage demand (as was the case in

<sup>44</sup> We may ignore the results on the whole period here since essentially they are capturing the mixed effects of both subsample periods.

the first subsample period). Thus during the 1980s and 1990s, mortgage lenders were able to offer higher loan to value ratios as a means of compensation to the borrower (in order to maintain mortgage demand) for enduring periods of high real mortgage interest rates.

### 7.2.6 Regime Shifts in the Mortgage Market

The change in sign of a small number of coefficients in the estimated reduced form equations has prompted the analysis in this section of the intertemporal stability of the parameters. Regime shifts between the two subsample periods will allow us to backcast using the estimated reduced form model for mortgages traded over the second subsample period in order to infer the degree to which disequilibrium mortgage rationing persisted in the mortgage market during the 1970s<sup>45</sup>.

One way in which we may test the conjecture that the estimated parameters of the reduced form mortgage equation changed over the period 1969Q1 to 1995Q4 is by undertaking rolling reduced form estimations over a subsample of periods 1 to  $t$  (representing the first  $t$  years of the total sample period) and then to re-estimate the relationships between periods 2 and  $(t+1)$  and so on until a final estimation on a subsample of the data between periods  $m$  and  $T$ , where  $T = (t + m - 1)$  is the total number of observations in the whole sample. In this case,  $m$  is chosen to be 48 quarters (12 years), representing the length of time of the shortest regime (that of the second subsample in the analysis above). The choice of  $m$  to be any longer than this would result in an over-smoothing of the observed path for the intertemporal coefficients and the model would in fact *never* be estimated on the competitive regime hypothesised to operate between 1984Q1 and 1995Q4.

Figure 7.8 below shows how the coefficients of the reduced form cointegrating model for the equilibrium level of mortgages traded change as we successively alter the estimation period. The dates on the charts relate to the years at which the estimation

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<sup>45</sup> Because of the significant amounts of output and analysis produced by the procedures of this section, we only discuss the way in which the parameters of the reduced form mortgage model have changed.



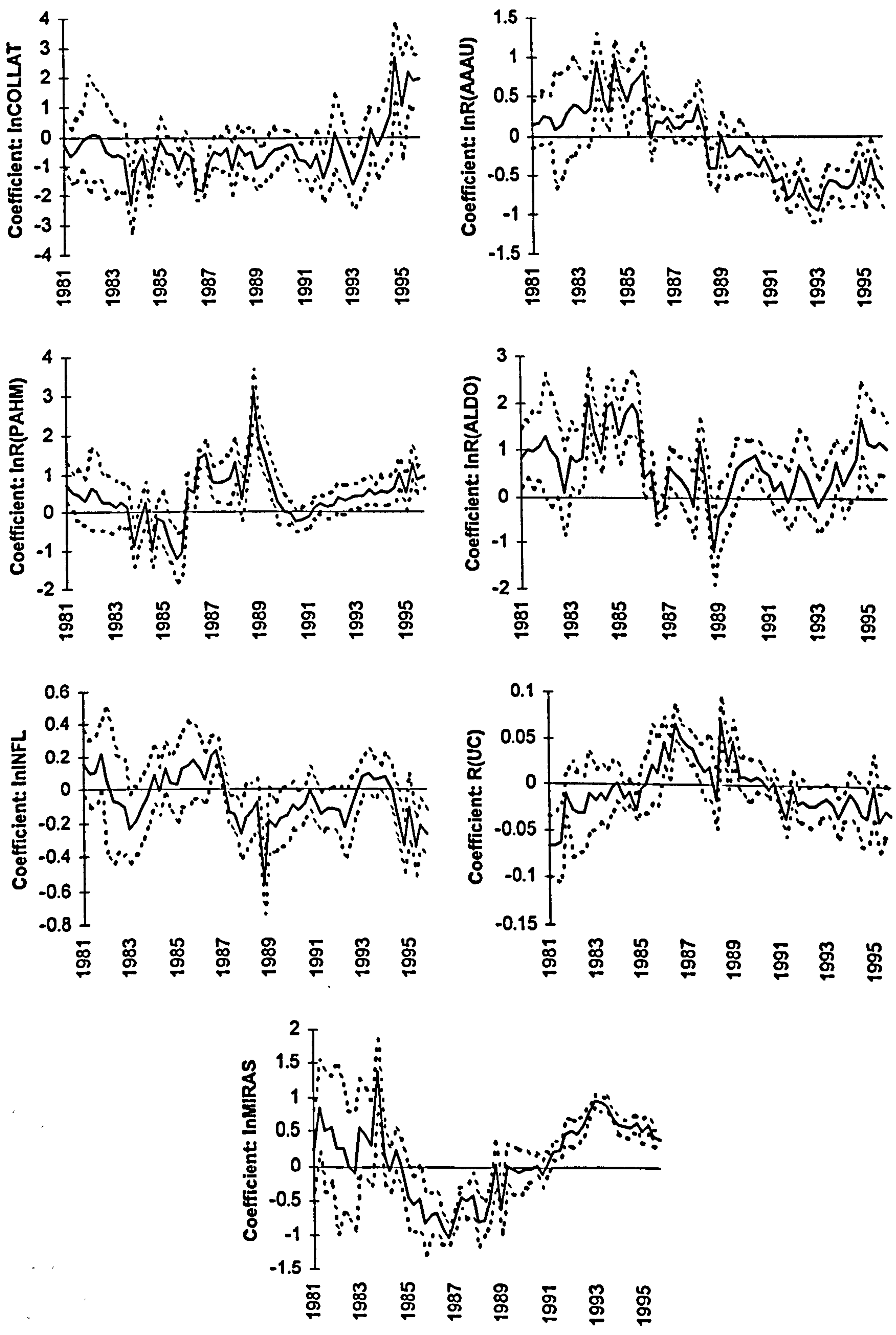
periods end, with the solid lines representing the coefficient paths and the dotted lines the 95 per cent confidence intervals. The charts indicate that the estimated parameters do vary substantially over time; for a number of coefficients in Figure 7.8 we are able to identify two or more distinct regimes.

The estimated parameters on the variable *lnCOLLAT* remained negative for almost the whole period with the exception of the regressions on the final seven periods. The performance of this variable thus appears to be unsatisfactory for the majority of the estimations, although it is possible to take heart from the fact that it is correctly signed to account for risk considerations in the most important final estimation periods (in which both demand and supply may be assumed to be identified)<sup>46</sup>. This is perhaps not surprising since the variable will be picking up an effect from the significant rise and subsequent dramatic fall in house prices during the late 1980s and early 1990s. The boom in the housing market during the period prior to 1990 would have led to an increase in the measure of collateral whilst the subsequent slump would have served to encourage mortgage lenders to become more 'risk conscious' (both of which are suggestive of a positive coefficient on *lnCOLLAT*). However, to reiterate the argument presented earlier in Section 7.2.5, the negative (and largely insignificant) coefficients in the remainder of the estimations may be attributed to the fact that prior to the early 1980s mortgage lending was constrained by the availability of funds rather than risk considerations. This ties in with the argument below for the way in which the coefficients on savings have changed over time.

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<sup>46</sup> In fact the variable was correctly signed for all three original sample periods illustrating the dangers of not undertaking the intertemporal analysis of the coefficients as we do in this section.

Figure 7.8 : The Intertemporal Paths of the Coefficients of the Reduced Form Mortgage Estimation





The coefficients on the measure of personal savings ( $\ln R(AAAU)$ ) have steadily declined over the estimation periods, being positive for approximately the first half of the sample periods and negative for the latter half (the coefficients in both periods enjoying a reasonable level of significance). It was originally postulated that higher personal savings per quarter would allow mortgage lenders to be more prepared to on-lend housing finance, implying a positive coefficient. However, as time has progressed, mortgage lenders have become less reliant on personal sector savings following their entrance to the wholesale deposit markets<sup>47</sup>. Thus the negative coefficients on the measure of savings indicate the rise in importance of the households' trade-off between savings and the downpayment on a house (the size of which is dependent upon the size of the mortgage loan as specified through the loan to value ratio) relative to the postulated supply effect.

The coefficients on house prices have been positive during almost every regression period, although were more highly positive for regressions estimated over the 12 years beginning between the final quarters of 1974 and 1977 (i.e. ending between the third quarters of 1986 and 1989). It is likely that this is the result of a considerably higher observed inflation rate during these periods serving to encourage investors to purchase real estate (and in particular to use relatively cheap mortgage finance) rather than financial assets, the real return on which fell dramatically during the mid- to late 1970s.

The financial wealth variable has generally enjoyed positive coefficients for most of the estimations despite being considerably smaller and in some cases negative from estimations beginning in 1974 (i.e. ending in 1986) onwards, although only significantly negative in two estimations. This may be seen as a confirmation of the theoretical prediction by Jones (1993) that in times of high inflation and sticky mortgage rates (causing the mortgage interest rate to be relatively low compared to the return to financial wealth) the negative impact of the wealth-substitutability argument would be diminished (see Section 6.2.2 and equation (6.4) of Chapter 6 for a lengthier discussion). As the sample period is extended further, the competitive equilibrium

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<sup>47</sup> Although banks have always been allowed to make investments and lend money in the wholesale deposit markets they have only been permitted to make mortgage loans since the early 1980s.

which has characterised the market since the early 1980s dominates and the positive effect on wealth begins to unwind. However, it may also be interpreted as a reduction in the influence of the wealth effect over time.

The coefficients on inflation have generally been lower and negative for regressions ending after 1987 (i.e. beginning after 1975), although prior to this are mainly positive. Indeed, the dramatic fall in the coefficient on inflation which can be seen towards the middle of the relevant chart above is consistent with the fact that the tilt or front loading problem discouraged mortgage demand to a greater extent during the period of high inflation between 1974 and 1980. Any positive effect on mortgage lending that might have occurred as a result of declining real returns to financial assets (i.e. alternative assets to housing) and a highly negative real rate of mortgage interest during the period were clearly more than offset by the compounding of the front loading problem.

The real user cost coefficients are negative for estimations beginning in the first four and a half years of the overall sample period as expected, following which they become positive for the middle regressions and resume on a negative path for estimations ending in 1990 and later. The finding of positive coefficients on  $R(UC)$  for estimations ending in the five years from 1985 onwards may be associated with the fact that we have not taken into consideration how average real rents have changed over the period. Given that renting is the main alternative to owner occupation, any such changes in rental yields may have had important spillover effects into the market for owner occupied housing.

Finally, the parameter estimates on  $\ln MIRAS$  fall for the first half of the estimations (with the exception of a highly positive spike in the coefficient path for the regression ending in the final quarter of 1983) then rise again reaching a local peak of almost 1 in the regression ending in 1993Q1 from which point on there has been an almost consistent fall. This fall may be attributed to the reduction in importance of MIRAS benefits during the 1990s (as a consequence of changes in the rate of deduction) feeding into the estimated coefficients of the final eleven estimations (1981Q3-



1993Q2 to 1984Q1-1995Q4). A possible reason for the observed negative coefficients during the middle estimations could be that with a high average unemployment rate during these periods the MIRAS scheme presented fewer opportunities to offset mortgage interest payments as income tax revenue was relatively lower.

The results presented in this section confirm the findings of Leece (1995) who argues for the presence of a regime shift in the mortgage market during the early 1980s based on changes in parameter values in an estimated cross section mortgage demand equation. Indeed, the trends exhibited in all of the charts of Figure 7.8 above appear reasonably strong and tell an intuitively appealing, plausible and consistent story, allowing us to confirm the shift in regime with a considerable degree of certainty.

### 7.2.7 Disequilibrium Rationing in the Mortgage Market

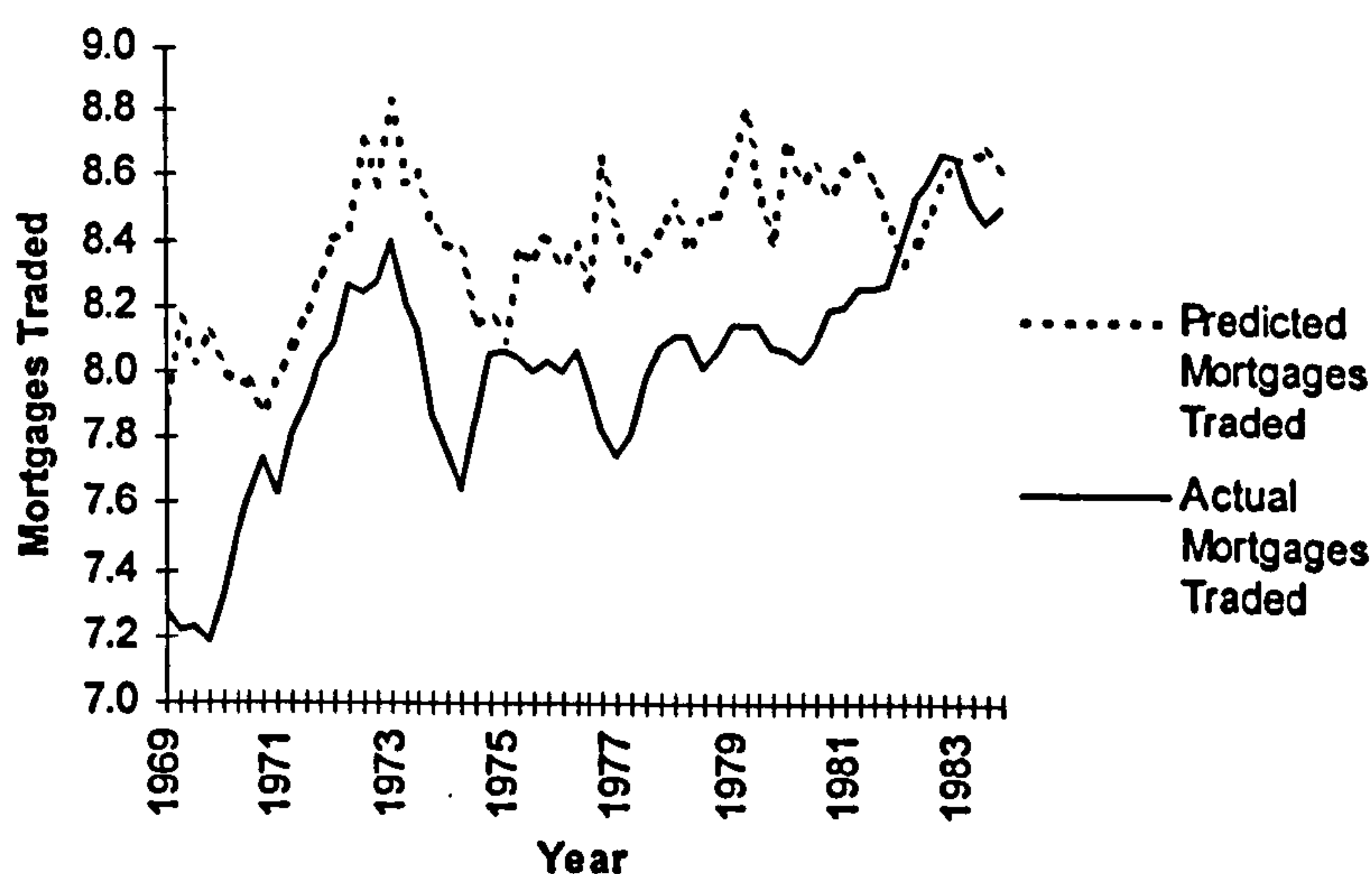
As we have discussed previously, no account of disequilibrium mortgage rationing is taken in any of the estimated equations, implying that *strictly* each reduced form equation should perform best over the period in which disequilibrium mortgage rationing does not exist (i.e. 1984Q1 to 1995Q4). In the previous section the reduced forms have been estimated over periods in which disequilibrium mortgage rationing has been alleged to be prominent, and thus it is important to be aware that these equations could be misspecified.

It will prove informative to measure the extent to which disequilibrium mortgage rationing prevailed in the market for mortgage finance during the 1970s, since thus far in the chapter disequilibrium rationing has simply been a conjecture based on documentary evidence and previous studies. A relatively simple way of estimating the amount of mortgage finance that was rationed out of the market by disequilibrium methods during the 1970s is to use the reduced form mortgage equation estimated over the second subsample to backcast the expected level of mortgages traded per period. The resulting series will represent the estimated amount of mortgages that would have been traded if disequilibrium rationing had been absent (i.e. notional

mortgage demand). If indeed disequilibrium rationing was a significant feature of the mortgage market during the 1970s then we would expect to observe the backcasted series to be greater than the observed amount of mortgages traded.

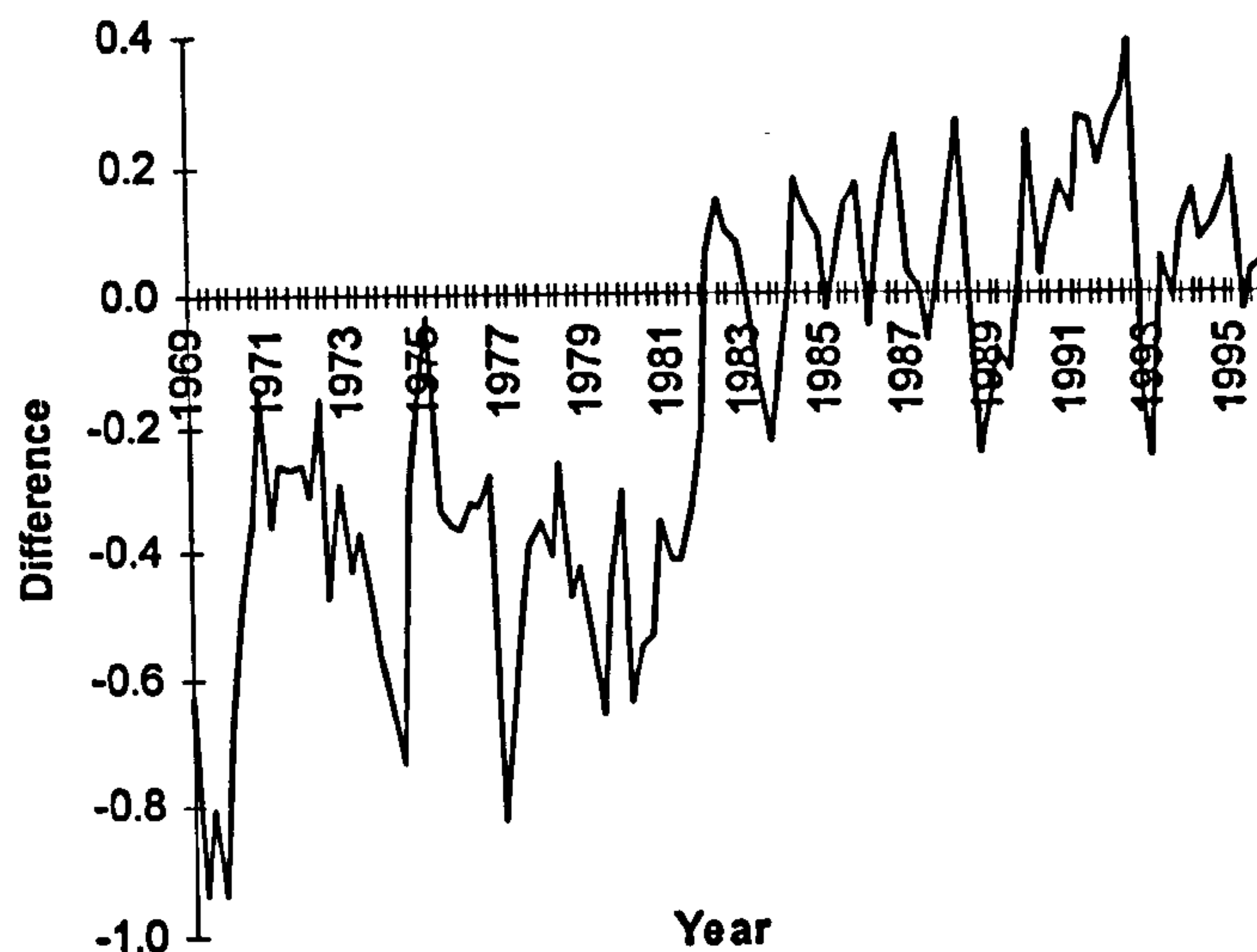
Figure 7.9 illustrates the results of the above procedure, confirming that disequilibrium rationing was indeed a prominent feature of mortgage lending during the 1970s. We may infer from the figure that during the 1970s, building societies were unable to manipulate sufficiently the loan to value ratio in order to match the relatively low levels of available funds with the high demand for mortgage finance (which had been encouraged by the lure of a low and steady rate of mortgage interest). To allow a more precise analysis of the extent of disequilibrium rationing, Figure 7.10 plots the difference between the logs of the actual and predicted series for mortgages traded.

**Figure 7.9 : Actual versus Predicted (Backcasted) Level of Mortgages Traded (in logarithms)**





**Figure 7.10 : The Difference Between Actual and Predicted (Backcasted) Levels of Mortgages Traded (in logarithms)**



Between 1984Q1 and 1995Q4, this difference is simply the residual series from the reduced form cointegrating mortgage regression estimated over that period. However, prior to 1984, we may refer to the graph as a 'backcasted residual series', indicating the amount of mortgage funds rationed out of the market as a result of mortgage queues, savings records and other disequilibrium rationing techniques.

From Figure 7.10, three peaks in the level of disequilibrium mortgage rationing are observed in the final quarter of 1969, the second quarter of 1974 and the final quarter of 1976. Converting the data in Figure 7.9 from its logarithmic form, in constant price terms (the base year being 1990) the estimated model predicts that in 1969Q4 an amount of £2,049.0m of mortgage lending was disequilibrium rationed, £2,281.5m in 1974Q2 and £3,185.3m in 1976Q4, all of these figures being greater than the actual quantity of mortgages traded during the respective periods. Over the whole of the 1970s, the model suggests that an average of £1,455m of mortgage finance per quarter was rationed out of the market whereas the average amount traded in the market was £2,959.8m per quarter. In other words, on average there was approximately 49 per cent more mortgage demand than the market could actually support.

One would be ill-advised to argue that the results presented above reflect precisely the extent of disequilibrium mortgage rationing prior to the competitive environment during the 1980s and 1990s; rather, they are likely to be an exaggeration of reality. Backcasting over such a long period of time will clearly yield residual estimates with large forecast errors and extremely wide confidence intervals. Nevertheless, the clear negative direction of the backcasted residuals before 1982 is surely convincing evidence to suggest the presence of considerable disequilibrium rationing. Indeed this is indicated by the calculation of a significantly negative matched-pairs  $t$ -statistic<sup>48</sup> of -12.28 for the difference between the actual and backcasted series over the first subsample period.

These results confirm the empirical analysis of Meen (1990b) who makes use of Hendry and Anderson's (1977) procedure to characterise mortgage rationing. Meen finds peaks in mortgage rationing around 1965/66, 1969, 1973 to 1975 and 1978/79 to 1980, results which are similar to those presented in this section. However, the results of this section contrast with those of Nellis and Thom (1983) who find no evidence to suggest the presence of disequilibrium mortgage rationing in the UK mortgage market between 1969Q1 and 1980Q4.

### 7.2.8 Estimation of the Short Run Dynamic Error Correction Model (ECM)

The Granger representation theorem states that the restrictions necessary to ensure that a set of variables are  $CI(1,1)$  will guarantee the existence of an error correction model; likewise, if there exists an error correction specification for a set of  $I(1)$  variables then this will in turn imply cointegration. The format of the error correction model is given by equation (7.13) of Section 7.2.4.

Table 7.10 below presents the short run dynamic ECM for the reduced form mortgage equation estimated over the second subsample period (1984Q2 to 1995Q4)<sup>49</sup>. We focus in this section on the reduced form mortgage ECM alone since the main purpose

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<sup>48</sup> See Section 5.2.4.2 of Chapter 5 for a discussion of the methodology of this test.

<sup>49</sup> The estimation period begins in Q2 (rather than Q1) of 1984 due to the inclusion of the lagged residual series from the cointegrating regression.



of this chapter is to identify an equation to determine the equilibrium amount of mortgages traded based on demand and supply factors; as such it is not necessary to estimate the reduced form mortgage interest rate and loan to value ratio ECMs in order to estimate the reduced form mortgage ECM. The error correction specification may be consistently estimated using OLS since the differenced variables in the regression are stationary (their level series are all  $I(1)$ ) and therefore the  $t$ -statistics are valid.

We noted in Section 6.4.2.3 of Chapter 6 that the cost of funds to the mortgage lender relative to the rate of mortgage interest received should be important in influencing the supply of mortgage lending. However, this measure could not be included in the cointegrating relationship since the series was found to be stationary. The error correction model allows us to include any number of additional contemporaneous stationary exogenous variables (denoted by  $w_t$  in equation (7.13)) which are considered to be important in influencing the change in quarterly mortgage lending. With the variable specified as the real difference between the three month inter-bank rate and the mortgage rate of interest (which is a measure of the real effective interest rate cost of undertaking additional mortgage lending), preliminary error correction estimations yielded no discernible improvement in either the results or diagnostic statistics over ECM estimations in which the variable was excluded. The ECM estimation presented below was therefore undertaken without this variable.

The short run reduced form dynamic mortgage equation is estimated with a constant and without a time trend (see earlier discussion), and there is no need to include dummy variables to reflect quarterly changes in housing market activity given that the data has previously been seasonally adjusted. It is assumed that *potentially* up to four lags of the exogenous variables may be important in determining the change in the endogenous variable in the reduced form ECM equation. Preliminary estimations are undertaken on the *complete* reduced form mortgage ECM specification in which all exogenous variables are included in the regression with four lags; for reasons of brevity these results are not reported here. This general model is then tested down (using both the  $t$ -statistics on the individual coefficients and  $F$ -tests for the joint



insignificance of the group of deleted variables) in order to achieve a more parsimonious specification for the short run ECM. It is important to follow such a procedure since we must recognise that high lags in some variables but not others will be important in the error correction representation and that the desire to include high lags must be traded off against the requirement of parsimony for the purposes of tractability.

The general ECM is specified such that the endogenous variable  $\ln R(AAPR)$  changes in response not only to changes in the exogenous variables and stochastic shocks (the latter denoted by  $u_t$  in equation (7.13)), but also to the previous period's deviation from long run equilibrium (as captured by the residual series from the three reduced form cointegrating regressions); the general ECM formulation also includes the lagged dependent variable on the right hand side. The results of testing down the model suggest that no reasonably parsimonious error correction specification exists in which either  $\Delta \ln R(AAPR)_{t-1}$  (the lagged dependent variable) or  $RESIDS_{t-1}$  (the residuals from the cointegrating loan to value relationship) are significant. Nevertheless, the specification remains a valid ECM since the lagged residual series from both the long run cointegrating reduced form mortgage and interest rate equations are significant, ensuring that, "the short-run dynamic model retains information about the long run relationship between the variables" (Drake and Holmes (1997)). These 'error correction terms' are denoted by  $RESIDS$  in the table below and are subscripted by  $m$  and  $r$  to denote that they are the residual series from the cointegrating reduced forms of  $\ln R(AAPR)$  and  $R(r_m)$  respectively.

For the reduced form mortgage ECM presented below, an  $F$ -statistic is calculated to confirm the null hypotheses that zero restrictions on the coefficients dropped from the complete ECM with four lags do indeed hold<sup>50</sup>. The LM test statistic of 2.4251 suggests that serial correlation of the residuals is not a problem in the model<sup>51</sup> and Chow tests confirm that the parameters of the model are stable between the periods

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<sup>50</sup> The  $F$  statistic is found to be 0.2726, which is less than the critical value of the  $F$  distribution with 26 and 11 degrees of freedom at the 5 per cent level implying that we cannot reject the null hypothesis.

<sup>51</sup> The LM statistic follows a  $\chi^2$  distribution with 4 degrees of freedom, which at the 95 per cent level has a critical value of 9.49.



1984Q2-1989Q4 and 1990Q1-1995Q4 (Chow 1 in Table 7.10 above) although the predictive failure test statistic exceeds slightly the 5 per cent critical value (Chow 2 in the above table)<sup>52</sup>. In the light of the tests undertaken earlier in Section 7.2.4.1 for the inclusion of a time trend in the estimation of the VAR, a variable addition test is performed to confirm that the error correction model shown in the table above *without* a time trend is indeed the appropriate specification<sup>53</sup>. Finally, the goodness of fit measures for the reduced form mortgage ECM may be considered reasonable.

**Table 7.10 : The Short Run Dynamic ECM**

Dependent Variable	$\Delta \ln R(AAPR)$
Constant	-0.0312 (-1.30)
$RESIDS_{mt-1}$	-0.4983 (-5.34)
$RESIDS_{rt-1}$	-0.0427 (-2.46)
$\Delta \ln COLLAT_{t-3}$	-9.2037 (-4.33)
$\Delta \ln R(PAHM)_{t-3}$	-1.1465 (-1.97)
$\Delta \ln R(ALDO)_{t-1}$	-0.8969 (-2.78)
$\Delta \ln R(ALDO)_{t-4}$	1.1785 (3.99)
$\Delta \ln INFL_{t-1}$	0.1695 (2.06)
$\Delta \ln MIRAS_{t-1}$	-0.9042 (-2.44)
$\Delta \ln MIRAS_{t-3}$	1.2392 (3.52)
$R^2$	0.6614
Adjusted $R^2$	0.5790
LM	2.4251
Chow 1 $\chi^2(10)$	15.2488
Chow 2 $\chi^2(24)$	39.2781

*t*-statistics in parentheses

The coefficient on the residual series ( $RESIDS_{mt-1}$ ) in the dynamic mortgage equation is both highly significant and fairly large, indicating that around half of the adjustment

<sup>52</sup> The critical values for  $\chi^2(10)$  and  $\chi^2(24)$  at the 5 per cent level are 18.31 and 36.42 respectively.

<sup>53</sup> The *F*-statistic for the inclusion of a time trend in the error correction model was calculated as 0.0671. With the critical value of the *F*-distribution at the 5 per cent significance level with (1,36) degrees of freedom being 4.11, we are unable reject the null hypothesis that the coefficient on the added time trend is zero.

of the quantity of mortgages traded to its long run value occurs during each quarter. This is in contrast to Drake and Holmes (1997) who find a considerably smaller adjustment parameter of less than 20 per cent for their individual demand and supply functions. The findings presented in this chapter therefore are particularly interesting since they lend support to the hypothesis that the market for mortgage finance has been characterised by a more rapidly clearing competitive equilibrium over the period of estimation.

The dynamics of the variables  $\Delta \ln \text{MIRAS}$  and  $\Delta \ln R(\text{ALDO})$  are also worth mentioning. The coefficients on the first and third lags of  $\Delta \ln \text{MIRAS}$  are of opposite sign, with the coefficient on the third lag being of greater magnitude (and significance) than that of the first. This would suggest that an increase in the generosity of MIRAS benefits will feed through (eventually) to a rise in the value of mortgages traded (as a result of demand side influences). Likewise, an increase in real financial wealth according to the model would initially lead to a fall in the equilibrium value of mortgages traded and an ensuing rise (of greater dimension) after 4 quarters. This would suggest that potential owner occupiers benefiting from a rise in wealth will in the first instance use the funds to increase their downpayment. The traditional wealth effect which will serve to raise the demand for owner occupied housing (and thus mortgage demand) then takes a further 3 quarters to filter through. Indeed, this is consistent with the literature on permanent income which suggests that only when a rise in wealth is believed to be permanent will it lead to increased consumption.

### 7.3 SUMMARY AND CONCLUSIONS

This chapter has examined the long run reduced form cointegrating relationships for the quantity of mortgages traded, the mortgage interest rate and the loan to value ratio, and the short run dynamic mortgage equation when the mortgage market is characterised by a situation of competitive equilibrium. The basic dynamics of the way in which the mortgage market operates in the presence of mortgage rationing were discussed and the difficulties involved in estimating structural equations for



mortgage supply and demand under conditions of disequilibrium have been investigated.

The difficulties in identifying a structural model of mortgage supply and demand were circumvented by estimating the reduced form equation over the period 1984 to 1995 in which the mortgage market was assumed to be in a state of competitive equilibrium. This allowed us to backcast the expected level of mortgages traded to a period in which the market was characterised by a regime of disequilibrium rationing and thus infer the extent of disequilibrium mortgage rationing during the 1970s and early 1980s. The model suggests that disequilibrium mortgage rationing was substantial throughout the 1970s and estimates of the amount of excess demand rationed from the market are presented and discussed.

Finally, the short run dynamic estimation of the reduced form mortgage equation suggests that the adjustment to long run equilibrium is speedy but that any positive response of mortgages traded to changes in the real level of personal financial assets is slow.

One obvious direction for further research would be the development of a simultaneous estimation technique for long run cointegrated variables. Although the Johansen technique allows us to restrict the cointegrating vectors to identify both supply and demand equations, it is well known that the Johansen estimates can often be lacking in any economic meaning. Being able to consistently estimate the parameters of simultaneous equations in a cointegrating framework would allow future researchers in the market for mortgage finance to present more credible structural parameters for mortgage demand and supply.

## CHAPTER 8

### Overall Summary and Conclusions

This thesis has investigated the issues of the repayment of long term mortgage debt, the determination of house prices and theoretical and empirical formulations of the supply of and demand for mortgage finance. Here we provide a summary of the main findings of the thesis.

No piece of work on the mortgage market can possibly be complete without an analysis of the structure of the market, this being the subject of Chapter 2. In the first instance, a number of competing theories of how the mortgage market interacts with the economy as a whole were addressed in order that the mortgage market may be set in a wider perspective. The evidence would appear to suggest that the housing and mortgage markets move in a pro-cyclical fashion with the rest of the economy. One mechanism through which this operates is that when the housing market is booming, the demand for consumer durables will rise, which in turn will boost aggregate demand. Alternatively, rising house prices may lead to a rise in housing equity withdrawal and a subsequent rise in consumption. In addition, pro-cyclicality will be generated to a large extent by the operation of monetary policy, which should have similar effects on household durable consumption as it does on housing demand.

Following an overview of the historical roots of the building society industry, the remainder of the chapter focused on the dramatic changes that have occurred in the mortgage market since the 1970s. The easing of legislation on both banks and building societies enhanced competition among the providers of mortgage finance and indeed encouraged new entrants into the market. The Building Societies Association rate-setting cartel could clearly no longer operate in such an environment and, since its abandonment in 1984, the process of interest rate setting has become considerably more competitive<sup>1</sup>. However, building societies were no longer able to maintain their

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<sup>1</sup> As discussed in the literature review of Chapter 1, this is recognised by Paisley (1994) who models the process of building society interest rate setting as one of profit maximisation.



dominance in the provision of mortgage finance, losing business both to banks and other new entrants in the mortgage market. Following the wave of big-name de-mutualisations beginning in 1989 with the Abbey National, building societies currently hold less than one quarter of the total value of all mortgages outstanding (compared with almost 85 per cent during the late 1970s). The legislative changes have not only altered the balance of mortgage lending between building societies and banks, but in promoting competition have enabled the elimination of the regime of mortgage rationing that existed throughout the 1970s.

Finally in Chapter 2, the motives for and trends in de-mutualisations, mergers and acquisitions in the building society sector are examined. The number of building societies in the UK has fallen considerably over the past two decades, from 273 in 1980 to only 71 at the end of 1998 primarily as a result of friendly mergers and take-overs. Underperformance is identified by Thompson (1997) as the major factor inducing merger and take-over activity, which may possibly be a reason that studies by Gough (1979) and Barnes (1985) find that little discernible benefit accrues to the acquirer society.

The investigation into the 'tilt' or 'front-loading' effect of inflation on the borrower's real mortgage repayment schedule was the subject of Chapter 3. A separate chapter was devoted to the topic due to its importance as one of the causes of mortgage default and as a determinant of mortgage demand (both of which were considered in depth in later chapters). The first half of the chapter showed that with certain types of mortgage contract, higher inflation can lead to higher real debt repayments during the initial years of the loan (even if the real mortgage rate remains constant). It was discussed that this could have two subsequent effects in the mortgage market. Firstly, those borrowers who continue to demand mortgage finance and those who already have a mortgage loan (not of the fixed rate type in the latter case) will face a greater probability of default the higher is the inflation rate (since the tilt effect will be more pronounced). Secondly, the demand for mortgages will be reduced among the group of *potential* owner occupiers when the rate of inflation rises.



The second half of the chapter considers the various mortgage designs which may ameliorate to some extent the front-loading problem. A number of different designs are discussed at length, and simulations of each over time are presented in the appendix to the chapter. Only the price level adjusted mortgage (PLAM) insulates the borrower completely from the tilt effect caused by both anticipated and unanticipated inflation. However, the insignificance of such mortgage designs in the UK and the prominence of variable and fixed rate mortgage contracts underlines the extent to which the tilt effect could be a serious problem to the borrower if the inflation rate were to rise. The value of including this chapter in the thesis is that not only does it give a background to the potential repayment problems investigated in the following chapters, but that it brings together a considerable volume of literature and may be considered a comprehensive reference on the problem of front-end loading.

Clearly, a number of policy issues emerge from the discussion of Chapter 3. The government has two options in order that the tilt problem may be further moderated. Firstly, inflationary pressures in the economy may be addressed more actively. However, with the Bank of England being recently given operational independence with an explicit objective of price level stability, the amount of further progress that may be made on this front is probably limited. Secondly, the government may wish to promote alternative mortgage designs amongst potential owner occupiers. It is likely that the encouragement of borrowers to hold alternative mortgage designs (in particular the PLAM) can only be achieved through generous financial incentives and a nationally co-ordinated educational advertisement campaign. As such, further research to aid in the identification of the group of potential mortgagors who would benefit the most from alternative mortgage designs would be particularly desirable, allowing mortgage lenders to be better able to target the most appropriate subset of borrowers.

Chapter 4 examined and re-estimated the models of real house prices, arrears and possessions proposed by Breedon and Joyce (1993) in a Bank of England working paper, the motivation for which has been the recent alarming trends in these variables. Following the economic boom and simultaneous surge in housing demand and



mortgage business during the late 1980s, the onset of recession in 1989 led to a dramatic and sustained fall in both real and nominal house prices. When combined with increasing unemployment (the rate of which rose from the third quarter of 1990), borrowers who had been made redundant and were suffering financial distress could no longer rely on the withdrawal of housing equity to support their mortgage repayments; the inevitable consequence was a sharp rise in both the number of households in arrears and the flow into possession.

In the theoretical model, real house prices are derived from a standard household optimisation procedure in which potential owner occupiers maximise utility over housing and non-housing consumption subject to a budget constraint and two equations of motion defining the evolution of the stock of housing and financial assets. The stock of arrears is modelled as being dependent upon the household's level of disposable income relative to interest payments on the mortgage loan and the amount and availability of unwithdrawn equity in the housing asset. Finally, possessions are modelled from the point of view of the lender, who will decide to possess only when the current value of the property exceeds its future resale value plus the borrowers mortgage repayments.

Turning to the empirical methodology, the technique used to estimate the long run relationships was that of Park's (1992) canonical cointegrating regression, its benefits lying in its efficiency and other desirable properties of the estimated coefficients. All equations were modified from those estimated by Breedon and Joyce, with respect to both the variables included and a number of other data specification issues<sup>2</sup>. House prices, in the long run, were found to be inelastic with respect to the measure of financial wealth, as expected. The coefficient on the rate of inflation was found to be positive, with the negative effect of the front-loading problem on housing demand being outweighed as the inflation variable captured some of the positive 'investment' effects which would otherwise have been absorbed by the real user cost (see equations (4.7) and (4.9) of Chapter 4). The separation of these two effects in models of housing demand and house prices has not thus far been satisfactorily achieved, and as

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<sup>2</sup> The extension of the sample period is shown to have an important effect on some of the parameter values, for example.

such should be a priority for future research. Finally, the estimation confirms the hypothesised negative influence of possessions on house prices. Action to prevent arrears occurring should thus be of paramount importance to policy-makers given the significance of the housing market in the wider economy.

In the estimation of the arrears equation, the largest and most significant effect comes from the unwithdrawn equity variable. This would suggest that the ability to withdraw equity from the property by either remortgaging or 'trading down' is important for borrowers who face financial difficulties. This lends more support to the theory that a fall in house prices (particularly when accompanied by recession) will lead to a rise in arrears, which in turn will increase the number of possessions; through the house price equation, the rise in possessions will then lead to a further fall in house prices and the downward spiral continues. A relaxation of the non-interest terms of the mortgage contract is also shown to lead to a rise in mortgage default. Surely, then, the recent dramatic rise in the loan to value ratio for first time buyers must be of particular concern amongst mortgage lenders and policy makers alike; it seems clear that not all of the lessons from the experience of the early 1990s have been learned. The final estimated long run equation for possessions highlights the importance of arrears in the determination of the flow into possession, in addition to the level of unwithdrawn equity in the borrower's property (as in the arrears equation). However, house prices are significant only at the 10 per cent level and the mortgage rate is shown to have no significant impact on the number of households possessed each period.

With regard future work in this area, attention should be directed towards the formulation of a more integrated theoretical model of house prices, arrears and possessions; ideally, such a model should also include the rental sector of the housing market. One would expect such a modelling strategy to yield more specific and rigorous testable assumptions.

Chapter 5 developed a formal model of building society interest rate setting behaviour in which societies chose their mortgage and savings interest rates to maximise a



particular objective function. The appropriate specification of the objective function is especially important; given the mutual status of UK building societies, one cannot simply assume the objective is one of profit maximisation. On the other hand, with the increasing trend in de-mutualisations and with a considerable number of societies accumulating large pools of reserves, neither would it be appropriate to conclude that societies are interested solely in maximising member benefits. As such, we follow the US credit union literature in specifying the objective as a weighted function of member financial benefits and additions to reserves. In order for the mathematics of the optimisation problem to be tractable, it is assumed that borrowing and saving members are not treated any differently to one another by societies, i.e. that the benefits allocated to each have the same weight in the objective function. There are compelling theoretical reasons to believe this to be true, although one must not lose sight of the fact that even in aggregate, savers are allocated greater monetary benefits by UK building societies than their borrower counterparts (the figures are relatively small but statistically significant). However, the important innovation here over the previous credit union literature is the inclusion of a behavioural parameter which allows building societies to choose the extent to which they wish to trade off the ability to meet fully the desires of their members with the accumulation of society reserves.

The significant finding reported in this chapter is that the optimal interest rate equations derived from the model under certain circumstances are independent of the behavioural parameter set by the society. In other words, the model suggests that up to a point a building society will not alter either its mortgage or savings rate if its preference in allocating financial benefits between its members and its reserve pool were to change. During the 1990s, we have seen that building societies have indeed been (implicitly) revising their behavioural parameters as more and more have geared up to following the route of de-mutualisation. The model would then predict that these societies in the process of planning for conversion should not alter their interest rates in response to their changing objectives, at least until profits command a larger weight in the objective function than do member benefits. Indeed, we have seen in the

UK mortgage market that de-mutualised societies speedily increased their mortgage rates and lowered their savings rates following the conversion.

There are certain circumstances in which the model is constrained as a result of the objective function becoming convex. As such, one may only state unequivocally that the model is appropriate when strictly more weight is attached to the profit motive of societies than is to member benefits. However, this need not necessarily be the case, and (unquantifiable) restrictions are presented in the main text of Chapter 5 which must hold for the model to be interpretable when more weight is attributed to member benefits. The model is important, therefore, since it tells us that *up to a point* building societies will leave their interest rates unchanged in the process of becoming more profit oriented.

Finally, we must also recognise that we have neglected a number of possible important factors in the model; the requirement that 'windfall' payments be paid to members of the society on conversion, the different rules under which building societies and banks operate, and the threat to the management of hostile take-overs in the corporate sector (although only once five years have elapsed following the conversion) particularly if the newly converted society is seen as underperforming. Essentially the model can, at most, account for a behavioural shift within the existing regime under which building societies operate.

The final two chapters of the thesis concentrated on the estimation of a long run cointegrating model of mortgage finance. In Chapter 6, following a discussion of the most appropriate theoretical models upon which to base the estimation, attention was focused upon some of the data issues involved in the empirical analysis<sup>3</sup>. In particular, the X11 procedure (described fully in Appendix 6.2) was used to seasonally adjust the raw data, and it was shown that use of an alternative and more simplistic dummy variable approach could in fact *induce* additional seasonality in the raw series.

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<sup>3</sup> There exist well-established theoretical models of mortgage demand, one of which is described in the chapter. However, the supply model of Chapter 5 could not be used given that recent building society mortgage lending data has not been break-adjusted for the conversion of societies to banks. As such, the analysis aimed to model the *total* mortgage flow across *all* mortgage lending institutions rather than solely that of building societies.



The variables to be included in the estimations of the final chapter were discussed at length, all of which were subjected to rigorous tests for stationarity.

One important issue was the generation of an expected house price series for inclusion in the user cost variable, which in the previous literature has been devoted little attention. Here, the full Box-Jenkins (1976) methodology was applied such that an appropriate ARMA model could be specified to make forecasts of future house price inflation; based on a number of diagnostic tests, the ARMA (2,2) model appeared to be the most suitable. One problem with ARMA modelling is that by its very nature, the predicted series will always be very dependent upon the actual series in the previous periods. Nevertheless, given that the expected house price inflation series was to be included as a component of the user cost variable which is designed to reflect the household's *expectation* of the cost of owner occupation, this naive measure of expected house price inflation may be considered appropriate.

Based on the analysis in Chapter 6, Chapter 7 estimated long run reduced form cointegrating relationships for the quantity of mortgages traded, the mortgage interest rate and the loan to value ratio, and also the short run dynamic mortgage equation. The first part of the chapter outlined some of the empirical issues involved when faced with a market which, for some considerable length of time, has been characterised by disequilibrium quantity rationing. A number of studies have estimated the period in which rationing was replaced by a regime of competitive equilibrium in the mortgage market and, on the basis of this and other anecdotal evidence, the long run cointegrating model was estimated using Park's (1992) canonical cointegrating approach over the period in which competitive equilibrium could be assumed to prevail (1984 to 1995). On the supply side, risk considerations (as proxied by an inverse mortgage gearing ratio) appeared to be important in the decision to supply additional mortgage funds, although the presence of the aggregate level of savings in the model tended to reflect a demand side influence rather than the ability of societies to supply mortgages. Turning to the demand side, a 1 per cent rise in real house prices was found to raise the real level of mortgages traded by 0.95 per cent as a result of raising the amount of mortgage required to purchase any given house and possibly an

investment demand effect. However, it was not possible to reject the null hypothesis that the coefficient was equal to unity (the relevant  $t$ -statistic was calculated as -0.35) and thus any positive effect that real house prices might have had on mortgage demand through the investment demand effect over and above that of the one-for-one price effect must have been offset by an equivalent reduction in demand as some households were priced out of the market. A negative coefficient on the inflation variable indicated that the tilting of real mortgage payments may have had an important effect on mortgage demand, while an increase in the real user cost measure was shown to decrease mortgage demand via its effect on housing demand.

Discussion in the previous literature has been sparse regarding the way in which building societies have set their mortgage interest rates and non-interest mortgage terms to allocate mortgage funds. An important and innovative contribution of this work has been to use the estimated long run equations for the mortgage interest rate and the loan to value ratio to investigate whether the two mortgage terms are used in a complementary or substitutable fashion. In the estimations undertaken over the period of competitive equilibrium, it is confirmed that mortgage lenders have used interest and non-interest mortgage terms as *alternatives* for each other in allocating mortgage funds, in contrast to the earlier period characterised by quantity rationing. Along with the observed changes in the coefficients of the mortgage equation over time, this may be seen as confirmation of the regime shift in the mortgage market over the last three decades.

The mortgage equation estimated over the period of competitive equilibrium was used to backcast the level of mortgages traded during the previous periods of disequilibrium mortgage rationing, thus allowing us to derive estimates of the magnitude of disequilibrium mortgage rationing during the 1970s and early 1980s. The model suggested that on average during the 1970s, a substantial 49 per cent of mortgage demand was rationed out of the market. In summary, the periods in which excess mortgage demand was found to be the strongest do coincide with those identified in the literature using various methodologies, although given the length of



the period over which the backcasting is undertaken, one would expect the 'forecast' errors would not be insignificant

Finally, turning to the short run dynamic estimation of the reduced form mortgage equation, the adjustment to long run equilibrium is found to be fairly rapid in relation to other studies' estimates, with almost half of the adjustment occurring in each quarter. On the other hand, the reaction of mortgages traded to real personal financial assets is found to be sluggish, with any positive adjustment occurring a whole year following any change.

In summing up, the contribution of this thesis has been to investigate the causes of borrowers facing difficulties in the repayment of long term mortgage finance (particularly in the light of the trends in arrears, possessions and house prices during the last decade), to consider theoretically the demand for and supply of mortgage finance and to propose and estimate a reduced form model of the mortgage market. In formulating the models constructed and estimated in this research, it was imperative that the idiosyncratic nature of the market was taken into account; the mortgage market has undergone a considerable compositional change over the past three decades which has led to increased competition, the end of mortgage rationing and, to a great extent, the dramatic rise in arrears and possessions during the early 1990s. Further research should be directed at tying the determination of house prices, arrears, possessions and the demand for and supply of mortgage finance more closely together, both from a theoretical and empirical perspective. With the mortgage market being the facilitator to the operation of the housing market, which in turn plays a significant role in the economy as a whole, the importance of mortgage market research cannot be emphasised enough.

## BIBLIOGRAPHY

- Abisogun, L., "Outlook for the UK Private Rental Market", *Housing Finance*, August 1992, No.15, 27-31
- Akaike, H., "A New Look at Statistical Model Identification", *IEEE Transactions on Automatic Control*, 1974, 19, 716-723
- Allen, C. and Milne, A., "Mismatch in the Housing Market", *Urban Studies*, 1994, 31(9), 1451-1463
- Alm, J. and Follain, J. R., "Alternative Mortgage Instruments : Their Effects on Consumer Housing Choices in an Inflationary Environment", *Public finance Quarterly*, April 1982, 10(2), 134-157
- Alm, J. and Follain, J. R., "Alternative Mortgage Instruments, the Tilt Problem, and Consumer Welfare", *Journal of Financial and Quantitative Analysis*, March 1984, 19(1), 113-126
- Anderson, G. J. and Hendry, D. F., "An Econometric Model of United Kingdom Building Societies", *Oxford Bulletin of Economics and Statistics*, August 1984, 46(3), 185-210
- Anderson, S., "Credit and Debt - A Consumer Overview of Mortgage Lending", *Housing Finance*, August 1990, No. 7, 16-21
- Antzoulatos, A. A., "Borrowing Constraints, Income Expectations and the Euler Equation, Theory and Evidence", *Economics Letters*, 1994, 45, 323-327
- Aptech Systems Inc., *The GAUSS System Version 3.0*, Aptech Systems Inc., Maple Valley WA, 1992
- Arcelus, F. and Meltzer, A. H., "The Markets for Housing and Housing Services", *Journal of Money Credit and Banking*, 1973, 5, 78-99
- Artle, R. and Varaiya, P., "Life Cycle Consumption and Homeownership", *Journal of Economic Theory*, 1978, 18, 38-58
- Askari, M., "A Disequilibrium Econometric Study of the Canadian Mortgage Market", *Applied Economics*, 1986, 18, 399-410
- Attfield, C. L. F., "Vector Error Correction Models and Permanent Variables", *University of Bristol Department of Economics*, July 1997
- Attfield, C. L. F., Demery, D. and Duck, N. W., "Unanticipated Monetary Growth, Output and the Price Level : UK 1946-77", *European Economic Review*, 1981, 16, 367-385



- Attfield, C. L. F. and Silverstone, B., "Okun's Coefficient : A Comment", *University of Bristol Department of Economics*, October 1994
- Attfield, C. L. F. and Winter, D. F., "A Time Series Model of the Housing Market", *University of Bristol Department of Economics*, Discussion Paper No. 93/358, August 1993
- Ball, L. and Mankiw, N. G., "Asymmetric Price Adjustment and Economic Fluctuations", *Economic Journal*, March 1994, 104(423), 247-261
- Ball, M., *Housing Policy and Economic Power : The Political Economy of Owner Occupation*, Methuen, London, 1983
- Ball, M., *Under One Roof : the International Financial Revolution and Mortgage Finance*, Harvester Wheatsheaf, Hemel Hempstead, 1990
- Baltenspurger, E., "Alternative Approaches to the Theory of the Banking Firm", *Journal of Monetary Economics*, 1980, 6, 1-37
- Bank of England, "Negative Equity in the Housing Market", *Bank of England Quarterly Bulletin*, August 1992, 32, 266-268
- Barnes, P., *Building Societies : The Myth of Mutuality*, Pluto Press, London, 1984
- Barnes, P., "Building Societies - A Study of the Gains from Merger", *Journal of Business, Finance and Accounting*, 1985, 12(1), 75-91
- Bartlett, M. S., "On the Theoretical Specification of Sampling Properties of Autocorrelated Time Series", *Journal of the Royal Statistical Society, Supplement*, 1946, 8, 27-41
- Basu, K., "The International Debt Problem, Credit Rationing and Loan Pushing : Theory and Experience", *Princeton Studies in International Finance*, October 1991, No. 70
- Bellman, H., *The Building Society Movement*, Methuen, London, 1927
- Berenson, M. L. and Levine, D. M., *Basic Business Statistics, Concepts and Applications*, Fourth Edition, Prentice-Hall International, Englewood Cliffs, New Jersey, 1989
- Berg, L. and Bergström, R., "Housing and Financial Wealth, Financial Deregulation and Consumption - The Swedish Case", *Scandinavian Journal of Economics*, 1995, 97(3), 421-439
- Beveridge, S. and Nelson, C. R., "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the 'Business Cycle'", *Journal of Monetary Economics*, 1981, 7, 151-174

Black, H. and Dugger, R. H., "Credit Union Structure, Growth and Regulatory Problems", *Journal of Finance*, May 1981, 36(2), 529-538

Board of Inland Revenue, *Inland Revenue Statistics*, HMSO, London

Boddy, M., *The Building Societies*, Macmillan, London, 1980

Boddy, M., "Financial Deregulation and UK Housing Finance : Government-Building Society Relations and the Building Societies Act, 1986", *Housing Studies*, 1991, 4(2), 92-104

Boléat, M., *The Building Society Industry*, Second Edition, Allen & Unwin, London, 1986

Boléat, M., "The Transformation of Rented Housing", *Housing Finance*, January 1989, No. 1, 8-15

Bourassa, S. C., "Marital Status and Homeownership in Australia", *Urban Research Program*, Australian National University, July 1993

Bourassa, S. C., "A Model of Housing Tenure Choice in Australia", *Urban Research Program*, Australian National University, August 1993

Bover, O., Muellbauer, J. and Murphy, A., "Housing, Wages and UK Labour Markets", *Oxford Bulletin of Economics and Statistics*, March 1989, 51(2), 97-136

Bowden, R. J., "Equilibrium and Disequilibrium in Models of the Housing Market : A Survey", in *National Housing Economics Conference 1978*, Australian Government Publishing Service, Sydney, 1980, 88-104

Box, G. E. P. and Jenkins, G. M., *Time Series Analysis : Forecasting and Control*, Holden Day, San Francisco, 1976

Box, G. E. P. and Pierce, D. A., "Distribution of Residual Autocorrelations in Autoregressive Integrated Moving Average Time Series Models", *Journal of the American Statistical Association*, December 1970, 65, 1509-1526

Breedon, F. J. and Joyce, M. A. S., "House Prices, Arrears and Possessions : A Three Equation Model for the UK", *Bank of England Working Paper Series*, No. 14, June 1993

Breusch, T. S. and Godfrey, L., "A Review of Recent Work on Testing for Auto-Correlation in Dynamic Simultaneous Models" in Currie, D., Nobay, R. and Peel, D. (eds.), *Macroeconomic Analysis : Essays in Macroeconomics and Econometrics*, Croom Helm, London, 1981

Breusch, T. S., "Testing for Autocorrelation in Dynamic Linear Models", *Australian Economic Papers*, 1978, 17, 334-355



- British Bankers' Association, *Annual Abstract of Banking Statistics*, British Bankers' Association, London, 1995
- Brookes, M., Dicks, M. and Pradhan, M., "An Empirical Model of Mortgage Arrears and Repossessions", *Economic Modelling*, 1994, 11(2), 134-144
- Browne, F. X., "Interest and Non-Interest Terms in the Process of Mortgage Market Clearing", *Economic and Social Review*, January 1988, 19(2), 71-97
- Brueckner, J. K., "The Downpayment Constraint and Housing Tenure Choice : A Simplified Exposition", *Regional Science and Urban Economics*, 1986, 16, 519-525
- Brueckner, J. K., "The Demand for Mortgage Debt : Some Basic Results", *Journal of Housing Economics*, 1994, 3, 251-262
- Buckingham, L., "Insurers Braced for Loan Defaults", *The Guardian*, 7 February 1990, 12
- Buckley, R. M. and Ermisch, J. F., "A Financial Model of House Price Behaviour in the United Kingdom", in Tuccillo, J. A. and Villani, K. E., (eds.), *House Prices and Inflation*, The Urban Institute, Washington DC, 1981
- Buckley, R., Lipman, B. and Persaud, T., "Mortgage Design Under Inflation and Real Wage Uncertainty : The Use of a Dual Index Instrument", *World Development*, 1993, 21(3), 455-464
- Building Societies Act 1986, HMSO, London
- Building Societies Association, *The Future Constitution and Powers of Building Societies*, Building Societies Association, London, 1983
- Building Societies Association, *New Legislation for Building Societies*, Building Societies Association, London, 1984
- Building Societies Association, *Building Societies Association Bulletin*, Building Societies Association, London
- Building Societies Association, *A Compendium of Building Society Statistics*, Building Societies Association, London
- Building Societies Association, *Housing Finance*, Building Societies Association, London
- Caballero, R. J., "Expenditure on Durable Goods : A Case for Slow Adjustment", *Quarterly Journal of Economics*, August 1990, 105, 727-743
- Callen, T. S. and Lomax, J. W., "The Development of the Building Societies Sector in the 1980s", *Bank of England Quarterly Bulletin*, November 1990, 30, 503-510

- Cameron, T. A., "Permanent and Transitory Income in Models of Housing Demand", *Journal of Urban Economics*, 1986, 20, 205-210
- Cargill, T. F., "Recent Research on Credit Unions : A Survey", *Journal of Economics and Business*, Winter 1977, 155-162
- Carroll, C. D., "How Does Future Income Affect Current Consumption ?", *Quarterly Journal of Economics*, February 1994, 109(1), 111-147
- Carruth, A. and Henley, A., "The Housing Market and Consumer Spending", *Fiscal Studies*, August 1990, 11(3), 27-38
- Carruth, A. and Henley, A., "Consumer Durables Spending and Housing Market Activity", *Scottish Journal of Political Economy*, August 1992, 39(3), 261-271
- Chiang, A. C., *Fundamental Methods of Mathematical Economics*, McGraw-Hill, New York, 1984
- Chiang, A. C., *Elements of Dynamic Optimisation*, McGraw-Hill, New York, 1992
- Choi, I. and Ahn, B. C., "Testing for Cointegration in a System of Equations", *Econometric Theory*, 1995, 11(5), 952-983
- Chow, G. C., "Test of Equality Between Sets of Coefficients in Two Linear Regressions", *Econometrica*, July 1960, 28(3), 591-605
- Chow, G. C. and Lin, A., "Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series", *Review of Economics and Statistics*, 1971, 53(4), 372-375
- Chow, G. C. and Lin, A., "Best Linear Unbiased Estimation of Missing Observations in an Economic Time Series", *Journal of the American Statistical Association*, September 1976, 71(355), 719-721
- CIPFA Statistical Information Service, *Council Tax Demands and Precepts 1997-98*, 1997
- Cleary, E. J., *The Building Society Movement*, Elek, London, 1965
- Cochrane, J. H., "Permanent and Transitory Components of GNP and Stock Prices", *Quarterly Journal of Economics*, February 1994, 109(1), 241-265
- Cohn, R. A. and Fischer, S., "Alternative Mortgage Designs" , in Modigliani, F. and Lessard, D. (eds.), *New Mortgage Designs for Stable Housing in an Inflationary Environment*, Federal Reserve Bank of Boston, Boston Mass., 1975
- Coles, A., "Causes and Characteristics of Arrears and Possessions", *Housing Finance*, February 1992, No. 13, 10-12



Committee to Review the Functioning of Financial Institutions, Final Report, Cmnd 7939, HMSO, London, 1980

Conijn, J., "The Dynamic Cost Principle in the Social Rented Sector in the Netherlands" in Bartlett, W. and Bramley, G., (eds.), *European Housing Finance : Single Market or Mosaic*, SAUS, Bristol, 1994

Cooley, T. F. and Ogaki, M., "A Time Series Analysis of Real Wages, Consumption and Asset Returns", *Journal of Applied Econometrics*, 1996, 11(2), 119-134

Copeland, T. E. and Weston, J. F., *Financial Theory and Corporate Policy*, Addison Wesley, Canada, 1992

Cosci, S., *Credit Rationing and Asymmetric Information*, Dartmouth, Aldershot, 1993

Council of Mortgage Lenders, "Income Support Cuts Threaten to Reverse Downward Trend in Arrears and Possessions", Press Release 10-30am Wednesday 25 January 1995

Dale, P., "Future Mortgage Default", *Housing Finance*, February 1995, No. 25, 14-20

Deaton, A. and Muellbauer, J., *Economics and Consumer Behaviour*, Cambridge University Press, Cambridge, 1980

Demery, D. and Duck, N., "Asymmetric Effects of Aggregate Demand : An Empirical Test of a Menu-Cost Model", *University of Bristol Department of Economics*, Discussion Paper No. 96/410, March 1996

Denton, N., "Halifax Job Cuts will be Offset by New Activities", *Financial Times*, 24 July 1996, 8

Department of the Environment, Transport and the Regions, *Housing and Construction Statistics Quarterly, Parts 1 and 2*, HMSO, London

Dhillon, U., Sa-Aadu, J. and Shilling, J. D., "Choosing Between Fixed- and Adjustable-Rate Mortgages : the Case of Commercial Mortgages", *Journal of Real Estate Finance and Economics*, 1996, 12, 265-277

Dhrymes, P. J. and Taubman, P. J., "An Empirical Analysis of the Savings and Loan Industry", in Friend, I. (ed.), *Study of the Savings and Loan Industry, Volume 1*, Federal Home Loan Bank Board, Washington, 1969, 69-183

Dickey, D. A. and Fuller, W. A., "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 1979, 84, 427-431

Dickey, D. A. and Fuller, W. A., "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", *Econometrica*, 1981, 49, 1057-1072

- Dickey, D. A. and Pantula, S. G., "Determining the Order of Differencing in Autoregressive Processes", *Journal of Business Economics and Statistics*, 1987, 5(4), 455-461
- DiPasquale, D. and Wheaton, W. C., "Housing Market Dynamics and the Future of Housing Prices", *Journal of Urban Economics*, 1994, 35(1), 1-27
- Dixit, A. K., *Optimisation in Economic Theory*, Second Edition, Oxford University Press, Oxford, 1990
- Doling, J. and Ford, J., "The Changing Face of Home Ownership : Building Societies and Household Investment Strategies", *Policy and Politics*, 1991, 19(2), 109-118
- Doling, J. and Stafford, B. R., "Regional Variations in Mortgage Arrears", *Area*, 1987, 19(2), 103-109
- Dougherty, A. and Van Order, R., "Inflation and Housing Costs", in Tuccillo, J. A. and Villani, K. E., (eds.), *House Prices and Inflation*, The Urban Institute, Washington DC, 1981
- Dougherty, A. and Van Order, R., "Inflation , Housing Costs and the Consumer Price Index", *American Economic Review*, March 1982, 72(1), 154-164
- Dougherty, C., *Introduction to Econometrics*, Oxford University Press, New York, 1992
- Down, D., Holmans, A. and Small, H., "Trends in the Size of the Private Rented Sector in England", *Housing Finance*, May 1994, No. 22, 7-11
- Drake, L. M., *The Building Society Industry in Transition*, Macmillan, Basingstoke, 1989
- Drake, L. M. and Holmes, M. J., "Adverse Selection and the Market for Building Society Mortgage Finance", *The Manchester School*, January 1997, 65(1), 58-70
- Driscoll, M., "Deregulation, Credit Rationing, Financial Fragility and Economic Performance", *OECD Department of Economics and Statistics*, Working Paper No. 97, February 1991
- Duca, J. V. and Rosenthal, S. S., "Borrowing Constraints and Access to Owner-Occupied Housing", *Regional Science and Urban Economics*, 1994, 24, 301-322
- Emran, M. S. and Shilpi, F., "Foreign Exchange Rationing and the Aggregate Import Demand Function", *Economics Letters*, 1996, 51, 315-322
- Enders, W., *Applied Econometric Time Series*, Wiley, New York, 1995
- Engle, R. F. and Granger, C. W. J., "Cointegration and Error-Correction : Representation, Estimation and Testing", *Econometrica*, March 1987, 55, 251-276



- Engle, R. F. and Yoo, B. S., "Forecasting and Testing in Cointegrated Systems", *Journal of Econometrics*, 1987, 35(1), 143-159
- Ermisch, J., "Measuring the Benefits from Subsidies to British Owner Occupiers and Tenants : Theory and Applications", *Policy Studies Institute*, mimeo, January 1984
- Fallis, G., *Housing Economics*, Butterworth, London, 1984
- Flannery, M. J., "An Economic Evaluation of Credit Unions in the United States", *Federal Reserve Bank of Boston*, Report No. 54, February 1974
- Flannery, M. J., "An Aggregate Model of the Credit Union Industry - Discussion", *Journal of Finance*, May 1981, 36(2), 554-556
- Follain, J. R., "Does Inflation Affect Real Behaviour : The Case of Housing", *Southern Economic Journal*, January 1982, 48, 570-582
- Follain, J. R. and Dunskey, R. M., "The Demand for Mortgage Debt and the Income Tax", *Syracuse University*, Working Paper, September 1996
- Ford, J. and Wilcox, S., *Reducing Mortgage Arrears and Possessions : An Evaluation of the New Initiatives*, Joseph Rowntree Foundation, York, 1992
- Foster, J., "The Demand for Building Society Shares and Deposits : 1961-1973", *Oxford Bulletin of Economics and Statistics*, 1975, 37, 319-341
- Fu, Y., "A Model of Housing Tenure Choice : Comment", *American Economic Review*, March 1991, 81(1), 381-383
- Fu, Y., "Uncertainty, Liquidity and Housing Choices", *Regional Science and Urban Economics*, 1995, 25, 223-236
- Gambs, C. M., "An Aggregate Model of the Credit Union Industry - Discussion", *Journal of Finance*, May 1981, 36(2), 552-554
- Gat, D., "Risk and Return in Residential Spatial Markets : An Empiric and Theoretic Model", *Journal of Real Estate Finance and Economics*, 1994, 9(1), 51-67
- Ghosh, D., *The Economics of Building Societies*, Saxon House, Farnborough, 1974
- Ghysels, E. and Perron, P., "The Effect of Seasonal Adjustment Filters on Tests for a Unit Root", *Journal of Econometrics*, 1993, 55(1-2), 57-98
- Godfrey, L., "Testing Against General Autoregressive and Moving Average Error Models when the Regressors Include Lagged Dependent Variables", *Econometrica*, 1978, 46, 1293-1302

- Goodman, A. C., "An Econometric Model of Housing Price, Permanent Income, Tenure Choice, and Housing Demand", *Journal of Urban Economics*, 1988, 23, 327-353
- Goodman, A. C., "A Dynamic Equilibrium Model of Housing Demand and Mobility with Transactions Costs", *Journal of Housing Economics*, 1995, 4, 307-327
- Goodman, A. C. and Kawai, M., "Permanent Income, Hedonic Prices, and Demand for Housing : New Evidence", *Journal of Urban Economics*, 1982, 12, 214-237
- Goodman, A. C. and Wassmer, R. W., "Optimal Mortgage Design when Transaction Costs Constrain Mobility", *Journal of Housing Economics*, 1992, 2, 17-36
- Goodman, J. L. Jr., "Adjustable-Rate Mortgages and Aggregate Demand for Mortgage Credit", *Journal of Housing Economics*, 1992a, 2, 1-16
- Goodman, J. L. Jr., "The Future Supply of Mortgage Credit", *Real Estate Review*, Spring 1992b, 22(1), 35-44
- Goodwin, T. H., "The Impact of Credit Rationing on Housing Investment : A Multi-Market Disequilibrium Approach", *International Economic Review*, June 1986, 27(2), 445-464
- Gough, T. J., "Building Society Mergers and the Size-Efficiency Relationship", *Applied Economics*, 1979, 11, 185-194
- Gough, T. J. and Taylor, T. W., *The Building Society Cartel*, Hobart Paper 83, Institute of Economic Affairs, 1979
- Granger, C. W. J. and Teräsvirta, T., *Modelling Non-linear Economic Relationships*, Oxford University Press, Oxford, 1993
- Greene, W. H., *Econometric Analysis*, Second Edition, Macmillan, New York, 1993
- Gujarati, D., *Essentials of Econometrics*, McGraw-Hill, New York, 1992
- Gujarati, D., *Basic Econometrics*, McGraw-Hill, New York, 1995
- Guttentag, J., "Credit Availability, Interest Rates and Monetary Policy", *Southern Economic Journal*, 1960, 26, 219-228
- Hadjimatheou, G., *Housing and the Mortgage Market*, Saxon House, Farnborough, 1976
- Hadley, G., *Linear Algebra*, Addison-Wesley, Reading Mass., 1965
- Hall, S. G. and Urwin, R. A., "A disequilibrium Model of Building Society Mortgage Lending", *Bank of England Discussion Paper*, July 1989



- Ham, J. C. and Melnik, A., "Loan Demand : An Empirical Analysis Using Micro Data", *Review of Economics and Statistics*, 1987, 69(4), 704-709
- Hamnett, C., "Restructuring Housing Finance and the Housing Market", in Corbridge, S., Thrift, N. and Martin, R. (eds.), *Money, Power and Space*, Blackwell, Oxford, 1994, 281-309
- Hannan, E. J. and Quinn, B. G., "The Determination of the Order of an Autoregression", *Journal of the Royal Statistical Society B*, 1979, 41(2), 190-195
- Harris, M., *Dynamic Economic Analysis*, Oxford University Press, New York, 1987
- Haug, A. A., "Tests for Cointegration : A Monte Carlo Comparison", *Journal of Econometrics*, 1996, 71(1-2), 89-115
- Haurin, D. R., "Income Variability, Homeownership, and Housing Demand", *Journal of Housing Economics*, 1991, 1, 60-74
- Haurin, D. R. and Gill, H. L., "Effects of Income Variability on the Demand for Owner-Occupied Housing", *Journal of Urban Economics*, 1987, 22, 136-150
- Hendershott, P. H. and Hu, S. U., "Inflation and Extraordinary Returns on Owner Occupied Housing : Some Implications for Capital Allocation and Productivity Growth", *Journal of Macroeconomics*, 1981, 3(2), 177-203
- Hendershott, P. H. and Van Order, R., "Integration of Mortgage and Capital Markets and the Accumulation of Residential Capital", *Regional Science and Urban Economics*, 1989, 19, 189-210
- Hendershott, P. H. and Villani, K. E., *Regulation and Reform of the Housing Finance System*, American Enterprise Institute for Public Policy Research, Washington, 1977
- Henderson, J. V. and Ioannides, Y. M., "A Model of Housing Tenure Choice", *American Economic Review*, March 1983, 73(1), 98-113
- Hendry, D. F., "Econometric Modelling of House Prices in the United Kingdom", in Hendry, D. F. and Wallis, K. F. (eds.), *Econometrics and Quantitative Economics*, Blackwell, Oxford, 1984
- Hendry, D. F. and Anderson, G. J., "Testing Dynamic Specification in Small Simultaneous Systems : An Application to a Model of Building Society Behaviour in the United Kingdom", in Intriligator, M. D. (ed.), *Frontiers in Quantitative Economics*, Vol IIIA, North Holland, Amsterdam, 1977, Chapter 8c, 361-383
- Henley, A., Disney, R. and Carruth, A., "Job Tenure and Asset Holdings", *Economic Journal*, March 1994, 104, 338-349

- Hewitt, V. N. and Thom, D. R., "An Econometric Model of Building Society Behaviour in Northern Ireland", *Scottish Journal of Political Economy*, June 1978, 25(2), 165-175
- Hewitt, V. N. and Thom, D. R., "An Econometric Model of Building Society Behaviour in Ireland", *Economic and Social Review*, October 1979, 11(1), 33-45
- Hill, D., "Flexible Loan Shows Future of Mortgages", *Sunday Times*, 7 September 1997
- Hills, J., *Unravelling Housing Finance : Subsidies, Benefits and Taxation*, Clarendon Press, Oxford, 1991
- HM Treasury, *HM Treasury Macroeconomic Model Technical Manual*, HM Treasury, 1982
- Holmans, A. E., "House Prices : Changes Through Time at National and Subnational Level", *Government Economic Service*, Working Paper No. 110, 1990
- Holmes, M. J., "The Demand for Building Society Mortgage Finance in Northern Ireland and Scotland", *Regional Studies*, 1993, 27(2), 103-108
- Hsiao, Cheng, "Cointegration and Dynamic Simultaneous Equations Model", *Econometrica*, May 1997, 65(3), 647-670
- Hsiao, Cheng, "Statistical Properties of the Two-Stage Least Squares Estimator Under Cointegration", *Review of Economic Studies*, 1997, 64, 385-398
- Huang, D. S., "The Short-Run Flows of Nonfarm Residential Mortgage Credit", *Econometrica*, April 1966, 34(2), 433-459
- Hudgins, S. C. and Morgan, G. E., "Regulatory Changes and Federal Mutual thrift Behaviour : Evidence from the 1980s", *Journal of Money, Credit, and Banking*, November 1993, 25(4), 828-853
- Ingham, H. and Wong, P., "Corporate Control in the UK Building Society Sector : An Examination of Failed Mergers", *The Service Industries Journal*, July 1994, 14(3), 352-368
- Ioannides, Y. M., "Housing, Other Real Estate, and Wealth Portfolios", *Regional Science and Urban Economics*, 1989, 19, 259-280
- Ioannides, Y. M. and Rosenthal, S. S., "Estimating the Consumption and Investment Demands for Housing and their Effect on Housing Tenure Status", *Review of Economics and Statistics*, 1994, 76(1), 127-141
- Jaffee, D. M., "An Econometric Model of the Mortgage Market", in Gramlich, E. M. and Jaffee, D. M. (eds.), *Savings Deposits, Mortgages, and Housing*, Studies for the Federal Reserve-MIT-Penn Economic Model, Lexington, 1972



- Jensen, M. C., "Agency Costs of Free Cash Flow, Corporate Finance and Takeovers", *American Economic Review*, 1986, 76(6), 323-329
- Johansen, S., "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, June-September 1988, 12, 231-254
- Johansen, S., "Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, November 1991, 59, 1551-1580
- Johansen, S. and Juselius, K., "Maximum-Likelihood-Estimation and Inference on Cointegration - With Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, 1990, 52(2), 169-210
- Jones, L. D., "Current Wealth and Tenure Choice", *Journal of the American Real Estate and Urban Economics Association*, 1989, 17(1), 17-40
- Jones, L. D., "Current Wealth Constraints on the Housing Demand of Young Owners", *Review of Economics and Statistics*, 1990, 72(3), 424-432
- Jones, L. D., "The Demand for Home Mortgage Debt", *Journal of Urban Economics*, 1993, 33, 10-28
- Jones, L. D., "Home Mortgage Debt Financing of Nonhousing Investments", *Journal of Real Estate Finance and Economics*, 1994, 9, 91-112
- Jones, L. D., "Net Wealth, Marginal Tax Rates and the Demand for Home Mortgage Debt", *Regional Science and Urban Economics*, 1995, 25, 297-322
- Jones, S. T., Miller, N. G. and Riddiough, T. J., "Residential Mortgage Choice : Does the Supply Side Matter ?", *Journal of Housing Economics*, 1995, 4, 71-90
- Joyce, M. A. S. and Kennedy, N. O., "The Determination of UK House Prices : Results from a Forward Looking Model", *Bank of England*, mimeo, June 1992
- Karafiath, I., "A Stochastic Model of the Competitive Banking Firm with Lagged and Contemporaneous Reserve Accounting", *Journal of Money, Credit, and Banking*, May 1985, 17(2), 253-257
- Kay, J. A. and King, M. A., *The British Tax System*, Fifth Edition, Oxford University Press, Oxford, 1990
- Kearl, J. R., "Inflation and Relative Price Distortions : The Case of Housing", *Review of Economics and Statistics*, November 1978, 60(4), 609-614
- Kearl, J. R., "Inflation, Mortgages and Housing", *Journal of Political Economy*, 1979, 87(5) Part 1, 1115-1138

- Kearl, J. R. and Mishkin, F. S., "Illiquidity, the Demand for Residential Housing, and Monetary Policy", *Journal of Finance*, December 1977, 32(5), 1571-1586
- Kearl, J., Rosen, K. and Swan, C., "Relationships Between the Mortgage Instruments, the Demand for Housing and Mortgage Credit : A Review of Empirical Studies", in Modigliani, F. and Lessard, D. (eds.), *New Mortgage Designs for Stable Housing in an Inflationary Environment*, Federal Reserve Bank of Boston, Boston Mass., 1975
- Kent, R. J., "Credit Rationing and the Home Mortgage Market", *Journal of Money Credit and Banking*, August 1980, 12(3), 488-501
- Kent, R. J., "A Disaggregated Model of the Residential Mortgage Market", *Southern Economic Journal*, 1981, 47(3), 714-727
- Klein, M. A., "A Theory of the Banking Firm", *Journal of Money, Credit, and Banking*, 1971, 3, 205-218
- Koot, R. S., "The Demand for Credit Union Shares", *Journal of Financial and Quantitative Analysis*, March 1976, 11(1), 133-141
- Lambert, Jean-Paul, *Disequilibrium Macroeconomic Models*, Cambridge University Press, Cambridge, 1988
- Lawrence, S., "Stand and Deliver", *The Banker*, August 1995, 10-11
- Lee, C. and Robinson, B., "The Fall in the Savings Ratio : The Role of Housing", *Fiscal Studies*, February 1990, 11(1), 36-52
- Leece, D., "Rationing, Mortgage Demand and the Impact of Financial Deregulation", *Oxford Bulletin of Economics and Statistics*, 1995, 57(1), 43-66
- Leigh Pemberton, R., "Structural Change in Housing Finance", *Bank of England Quarterly Bulletin*, December 1986, 26, 528-531
- Lessard, D. and Modigliani, F., "Inflation and the Housing Market : Problems and Potential Solutions", in Modigliani, F. and Lessard, D. (eds.), *New Mortgage Designs for Stable Housing in an Inflationary Environment*, Federal Reserve Bank of Boston, Boston Mass., 1975
- Lex Column, "Society Drop-Outs", *Financial Times*, 1 February 1996, 22
- Leyshon, A. and Thrift, N., "The Restructuring of the UK Financial Services Industry in the 1990s : A Reversal of Fortune ?", *Journal of Rural Studies*, 1993, 9(3), 223-241
- Linneman, P. and Wachter, S., "The Impacts of Borrowing Constraints on Homeownership", *Journal of the American Real Estate and Urban Economics Association*, 1989, 17(4), 389-402



- Liu, P., *Dynamic Optimisation and Mathematical Concepts*, Plenum Press, New York, 1980
- Ljung, G. M. and Box, G. E. P., "On a Measure of Lack of Fit in Time Series Models", *Biometrika*, 1978, 65, 297-303
- Mabey, S. and Tillet, P., "Building Societies : The Need for Reform", *Bow Group Research Paper*, 1980
- MacDonald, R. and Marsh, I. W., "On Fundamentals and Exchange Rates : A Casselian Perspective", *The Review of Economics and Statistics*, 1997, 79(4), 655-664
- MacKinnon, J., "Critical Values for Cointegration Tests", in Engle, R. F. and Granger, C. W. J. (eds.), *Long-Run Economic Relationships*, Oxford University Press, Oxford, 1991
- Malpezzi, S. and Mayo, S. K., "User Cost and Housing Tenure in Developing Countries", *Journal of Development Economics*, 1987, 25, 197-220
- Mankiw, N. G., "Hall's Consumption Hypothesis and Durable Goods", *Journal of Monetary Economics*, 1982, 10, 417-425
- Mankiw, N. G. and Weil, D. N., "The Baby Boom, the Baby Bust, and the Housing Market", *Regional Science and Urban Economics*, 1989, 19, 235-258
- Marcis, R. G., "The Housing and Mortgage Market Implications of Alternative Mortgage Instruments : A Review of AMIRS Research", in *National Housing Economics Conference 1978*, Australian Government Publishing Service, Sydney, 1980, 326-334
- Markandya, A. and Pemberton, M., "The Estimation of a Disequilibrium Model of the Housing Market - An Application to the United Kingdom", *Department of Political Economy*, UCL, May 1984
- Marquardt, D. W., "An Algorithm for Least Squares Estimation of Nonlinear Parameters", *Journal of the Society for Industrial and Applied Mathematics*, 1963, 11(2), 431-441
- Marshall, J. N., Richardson, R., Raybould, S. and Coombes, M., "The Transformation of the British Building Society Movement : Managerial Divisions and Corporate Reorganisation, 1986-1997", *Geoforum*, 1997, 28(3-4), 271-288
- Masih, R. and Masih, A. M. M., "Stock-Watson Dynamic OLS (DOLS) and Error-Correction Modelling Approaches to Estimating Long- and Short-Run Elasticities in a Demand Function : New Evidence and Methodological Implications from an Application to the Demand for Coal in Mainland China", *Energy Economics*, 1996, 18, 315-334

- McFayden, S. and Hobart, R., "An Alternative Measurement of Housing Costs and the Consumer Price Index", *Canadian Journal of Economics*, February 1978, 11, 105-112
- Meen, G. P., "An Econometric Analysis of Mortgage Rationing", *Government Economic Service*, Working Paper No. 79, July 1985
- Meen, G. P., "The Ending of Mortgage Rationing and its Effects on the Housing Market : A Simulation Study", *Urban Studies*, 1989, 26, 240-252
- Meen, G. P., "The Removal of Mortgage Market Constraints and the Implications for Econometric Modelling of UK House Prices", *Oxford Bulletin of Economics and Statistics*, February 1990a, 52(1), 1-23
- Meen, G. P., "The Measurement of Rationing and the Treatment of Structural Change in the UK Mortgage Market", *Journal of Applied Econometrics*, 1990b, 5, 167-187
- Meltzer, A. H., "Credit Availability and Economic Decisions : Some Evidence from the Mortgage and Housing Markets", *Journal of Finance*, 1974, 29, 763-777
- Miller, R. E., *Dynamic Optimisation and Economic Applications*, McGraw-Hill, London, 1979
- Mills, G., *Optimisation in Economic Analysis*, Allen and Unwin, London, 1984
- Molyneux, P., *Banking : An Introductory Text*, Macmillan, Basingstoke, 1991
- Montalvo, J. G., "Comparing Cointegrating Regression Estimators : Some additional Monte Carlo Results", *Economics Letters*, 1995, 48, 229-234
- Morgan, D. P., "Bank Credit Commitments, Credit Rationing, and Monetary Policy", *Journal of Money, Credit and Banking*, 1994, 26(1), 87-101
- Morishima, M., *Dynamic Economic Theory*, Cambridge University Press, Cambridge, 1996
- Muellbauer, J. "Anglo-German Differences in Housing Market Dynamics", *European Economic Review*, 1992, 36(2-3), 539-548
- Muellbauer, J. and Murphy, A., "Why Has UK Personal Saving Collapsed ?", *Credit Suisse First Boston Research Paper*, July 1989
- Muellbauer, J. and Murphy, A., "The UK Current Account Deficit", *Economic Policy*, October 1990, 11, 347-395
- Muellbauer, J. and Murphy, A., "Booms and Busts in the UK Housing Market", *The Economic Journal*, November 1997, 107, 1701-1727



- Muscatelli, V. A., Srinivasan, T. G. and Vines, D., "Demand and Supply Factors in the Determination of NIE Exports : A Simultaneous Error-Correcting Model for Hong Kong", *The Economic Journal*, November 1992, 102, 1467-1477
- Muth, R. F., "The Supply of Mortgage Lending", *Journal of Urban Economics*, 1986, 19, 88-106
- Muth, R. F. and Goodman, A. C., *The Economics of Housing Markets*, Harwood Academic Publishers, Chur, 1989
- Navratil, F. J., "An Aggregate Model of the Credit Union Industry", *Journal of Finance*, May 1981, 36(2), 539-549
- Nellis, J. G. and Longbottom, J. A., "An Empirical Analysis of the Determination of House Prices in the United Kingdom", *Urban Studies*, 1981, 18(1), 9-21
- Nellis, J. G. and Thom, R., "The Demand for Mortgage Finance in the United Kingdom", *Applied Economics*, 1983, 15(4), 521-529
- Ng, S. and Perron, P., "Unit Root Tests in ARMA Models with Data-Dependent Methods for the Selection of the Truncation Lag", *Journal of the American Statistical Association*, March 1995, 90(429), 268-281
- Office for National Statistics, *Annual Abstract of Statistics*, HMSO, London
- Office for National Statistics, *Economic Trends*, HMSO, London
- Office for National Statistics, *Financial Statistics*, HMSO, London
- Office for National Statistics, *Monthly Digest of Statistics*, HMSO, London
- Office for National Statistics, *United Kingdom National Accounts (Blue Book)*, HMSO, London
- O'Herlihy, C. St J. and Spencer, J. E., "Building Societies Behaviour, 1955-70", *National Institute Economic Review*, 1972, 61, 40-52
- Ostas, J. R. and Zahn, F., "Interest and Non-Interest Credit Rationing in the Mortgage Market", *Journal of Monetary Economics*, 1975, 1, 187-201
- Osterwald-Lenum, M., "A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics", *Oxford Bulletin of Economics and Statistics*, 1992, 54(3), 461-472
- Otero, J. and Smith, J., "The Effects of Seasonal Adjustment Linear Filters on Cointegrating Equations : A Monte Carlo Investigation", *Warwick Economic Research Papers*, No. 456, March 1996

Ouliaris, S. and Phillips, P. C. B., *Coint 2.0a : GAUSS Procedures for Cointegrated Regressions*, 1995

Pain, N. and Westaway, P., "Modelling Structural Change in the UK Housing Market : A Comparison of Alternative Approaches to Modelling House Prices in the UK", *National Institute of Economic and Social Research*, mimeo, 1996

Paisley, J., "A Model of Building Society Interest Rate Setting", *Bank of England Working Paper Series*, No. 22, June 1994

Park, J. Y., "Canonical Cointegrating Regressions", *Econometrica*, January 1992, 60(1), 119-143

Parkin, M. and Bade, R., *Modern Macroeconomics*, Second Edition, Philip Allan, Oxford, 1988

Patin, R. P. Jr. and McNiel, D. W., "Benefit Imbalances among Credit Union Member Groups : Evidence of Borrower-Dominated, Saver-Dominated and Neutral Behaviour ?", *Applied Economics*, 1991, 23, 769-780

Patterson, K. D., "Consumers' Expenditure on Non-Durables and Services and Housing Equity Withdrawal in the United Kingdom", *Manchester School of Economic and Social Studies*, September 1994, 62(3), 251-274

Pesaran, M. H., "Long-Run Structural Modelling", *University of Cambridge Department of Applied Economics*, Discussion Paper, July 1997

Pesaran, M. H. and Pesaran, B., *Microfit 3.0 : An Interactive Econometrics Software Package*, Oxford University Press, Oxford, 1991

Pesaran, M. H. and Pesaran, B., *Microfit 4.0*, Oxford University Press, Oxford, 1997

Pesaran, M. H. and Shin, Y., "Long Run Structural Modelling", *University of Cambridge Department of Applied Economics*, Unpublished Paper, 1995

Pesaran, M. H., Shin, Y. and Smith, R. J., "Testing for the Existence of a Long-Run Relationship", *University of Cambridge Department of Applied Economics*, Working Paper No. 9622, 1996a

Pesaran, M. H., Shin, Y. and Smith, R. J., "Structural Analysis of Vector Error Correction Models with Exogenous  $I(1)$  Variables", *University of Cambridge Department of Applied Economics*, Working Paper No. 9706, 1996b

Peterson, R. L., "An Aggregate Model of the Credit Union Industry - Discussion", *Journal of Finance*, May 1981, 36(2), 550-552

Peterson, R. L. and Kidwell, D. S., "Credit Union Participation in the Mortgage Markets", *Nebraska Journal of Economics and Business*, 1983, 22(1), 45-57



- Phillips, B. H., *Building Society Finance*, Van Nostrand Reinhold in association with the Chartered Building Societies Institute, Wokingham, 1983
- Phillips, P. C. B., "Fully Modified Least Squares and Vector Autoregression", *Cowles Foundation Discussion Paper*, No. 1047, Yale University, 1983
- Phillips, P. C. B. and Durlauf, S. N., "Multiple Time Series with Integrated Variables", *Review of Economic Studies*, 1986, 53, 473-496
- Phillips, P. C. B. and Hansen, B. E., "Statistical Inference in Instrumental Variables Regression with  $I(1)$  Processes", *Review of Economic Studies*, 1990, 57, 99-125
- Phillips, P. C. B. and Perron, P., "Testing for a Unit Root in Time Series Regression", *Biometrika*, June 1988, 75, 335-346
- Pindyck, R. S. and Rubinfeld, D. L., *Econometric Models and Economic Forecasts*, Third Edition, McGraw-Hill, New York, 1991
- Poirier, D., "Piecewise Regression Using Cubic Splines", *Journal of the American Statistical Association*, September 1973, 68(343), 515-524
- Poterba, J. M., "Tax Subsidies to Owner Occupied Housing : An Asset Market Approach", *Quarterly Journal of Economics*, November 1984, 99, 729-752
- Pratt, M. J., "Building Societies : An Econometric Model", *Bank of England Discussion Paper*, No. 11, 1980
- Price, S., *Building Societies : Their Origin and History*, Franey, London, 1958
- Prisman, E. Z., Slovin, M. B. and Sushka, M. E., "A General Model of the Banking Firm Under Conditions of Monopoly, Uncertainty and Recourse", *Journal of Monetary Economics*, 1986, 17, 293-304
- Ranney, S. I., "Capital Market Imperfections in a Model of House Purchase Decisions", *University of Wisconsin-Madison*, Unpublished Doctoral Dissertation, 1978
- Ranney, S. I., "The Future Return to Houses, Mortgage Market Conditions, and the Returns to Homeownership", *American Economic Review*, June 1981, 71(3), 323-333
- Reid, M., *Abbey National Conversion To Plc*, Pencorp, London, 1991
- Reilly, B. and Witt, R., "Regional House Prices and Possessions in England and Wales : An Empirical Analysis", *Regional Studies*, 1994, 28(5), 475-482
- Rosen, H. S., Rosen, K. T. and Holtz-Eakin, D., "Housing Tenure, Uncertainty, and Taxation", *Review of Economics and Statistics*, 1984, 66, 405-416

- Rothenburg, J., "Housing Investment, Housing Consumption and Tenure Choice", in Grieson, R. E. (ed.), *The Urban Economy and Housing*, Lexington Books, Lexington Mass., 1983, 29-55
- Sandilands, R. J., *Monetary Correction and Housing Finance in Columbia, Brazil and Chile*, Gower, Farnborough, 1980
- Santomero, A. M., "Modelling the Banking Firm", *Journal of Money, Credit, and Banking*, 1984, 16(4), 576-602
- Sargent, T., *Dynamic Macroeconomics*, Harvard University Press, Cambridge Mass., 1987
- Schwab, R. M., "Inflation Expectations and the Demand for Housing", *American Economic Review*, March 1982, 72(1), 143-53
- Schwartz, G., "Estimating the Dimension of a Model", *The Annals of Statistics*, 1978, 6, 461-464
- Schwert, G. W., "Tests for Unit Roots : A Monte Carlo Investigation", *Journal of Business and Economic Statistics*, 1989, 7, 147-160
- Scott, W. H. Jr., Houston, A. L. Jr. and Do, A. Q., "Inflation Risk, Payment Tilt, and the Design of Partially Indexed Affordable Mortgages", *Journal of the American Real Estate and Urban Economics Association*, 1993, 21(1), 1-25
- Serena, N. and Perron, P., "Unit Root Tests in ARMA Models with Data Dependent Methods for the Selection of the Truncation Lag", *Journal of the American Statistical Association*, March 1995, 90(429), 268-281
- Sharpe, I. G., "A Mortgage Model : Some Theoretical and Empirical Results as Applied to Australian Savings Banks", *Australian Economic Papers*, December 1973
- Silber, W. L., "An Econometric Model of the Mortgage Market", in Sametz, A. W. (ed.), *Cyclical and Growth Problems Facing the Savings and Loan Industry*, Bulletin No. 46-47, New York University Institute of Finance, New York, March 1968
- Silber, W. L., *Portfolio Behaviour of Financial Institutions*, Holt, Rinehart and Winston, New York, 1970
- Simonovits, A., "Indexed Mortgages and Expectations : Mathematical Analysis and Simulation", *Acta Oeconomica*, 1992, 44(1-2), 141-160
- Sims, C. A., "Seasonality in Regression", *Journal of the American Statistical Association*, 1974, 69, 618-626
- Sinkey, J. F. Jr., "An Analysis of the Causes of Savings and Loan Association Failures, by George J. Benston", *Journal of Money Credit and Banking*, Book Review, 1989, 21(1), 130-133



- Smith, A., "Halifax is to Close 120 High Street Branches", *Financial Times*, 22 February 1996a, 6
- Smith, A., "Lower Debt Charge Helps Lift Woolwich to £333m", *Financial Times*, 23 February 1996b, 19
- Smith, A., "Sharing Out or Issuing Shares is the Issue : Nationwide's Move Puts Pressure on Other Societies to Clarify their Approach to Mutuality", *Financial Times*, 23 February 1996c, 7
- Smith, D. J., "A Theoretic Framework for the Analysis of Credit Union Decision Making", *Journal of Finance*, September 1984, 39(4), 1155-1168
- Smith, D. J., "A Test for Variant Objective Functions in Credit Unions", *Applied Economics*, 1986, 18, 959-970
- Smith, D. J., "Credit Union Rate and Earnings Retention Decisions under Uncertainty and Taxation", *Journal of Money Credit and Banking*, February 1988, 20(1), 119-131
- Smith, D. J., Cargill, T. F. and Meyer, R. A., "Credit Unions : An Economic Theory of a Credit Union", *Journal of Finance*, May 1981, 36(2), 519-528
- Smith, G. and Brainard, W., "A Disequilibrium Model of Savings and Loan Associations", *Journal of Finance*, December 1982, 37, 1277-1293
- Smith, L. B., "A Model of the Canadian Housing and Mortgage Markets", *Journal of Political Economy*, 1979, 77, 795-816
- Smith, L. B. and Sparks, G. R., "The Interest Sensitivity of Canadian Mortgage Flows", *Canadian Journal of Economics*, August 1970, 3, 407-421
- Smith, M. E. H., *Guide to Housing*, Third Edition, Housing Centre Trust, London, 1989
- Smyth, D. J. and Arora, H., "A Temporary Equilibrium Model of the Mortgage Market", *Journal of Macroeconomics*, Spring 1989, 11(2), 261-268
- Spencer, J. E., "An Extension to Taylor's Model of Credit Unions", *Review of Social Economy*, Spring 1996, 54(1), 89-98
- Stahl, K., "Recent Issues in the Economics of Housing Markets, *Regional Science and Urban Economics*, 1990, 2, 1-4
- Stansell, S. R. and Mitchell, A. C., "The Impact of Credit Rationing on the Real Sector : A Study of the Effect of Mortgage Rates and Terms on Housing Starts", *Applied Economics*, 1985, 17, 781-800
- Stiglitz, J. E. and Weiss, A., "Credit Rationing in Markets with Imperfect Information", *American Economic Review*, June 1981, 71(3), 393-410

- Stock, J. H., "Asymptotic Properties of the Least Squares Estimators of Cointegrating Vectors", *Econometrica*, 1987, 55, 1035-1056
- Stock, J. H. and Watson, M. W., "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems", *Econometrica*, July 1993, 61(4), 783-820
- Stokey, N. L. and Lucas, R. E. with Prescott, E. C., *Recursive Methods in Economic Dynamics*, Harvard University Press, Cambridge Mass., 1989
- Suddards, C. G., "The Behaviour of Building Societies and the Variability of the Mortgage Rate", *The South African Journal of Economics*, 1983, 51(4), 530-543
- Suits, D. B., Mason, A. and Chan, L., "Spline Functions Fitted by Standard Regression Methods", *Review of Economics and Statistics*, February 1978, 60, 132-139
- Sunday Times, *Landlords Can Have Loan Linked to Rent*, 7 September 1997
- Swank, J., "Oligopoly in Loan and Deposit Markets : An Econometric Application to the Netherlands", *De Economist*, 1995, 143(3), 353-366
- Taylor, R. A., "The Credit Union as a Co-operative Institution", *Review of Social Economy*, September 1971, 29(2), 207-217
- Taylor, R. A., "Credit Unions and Economic Efficiency", *Rivista Internazionale Di Scienze Economiche E Commerciali*, 1977, 24, 239-247
- Taylor, R. A., "Demand for Labour by Credit Unions", *Applied Economics*, 1979, 11, 333-340
- Taylor, R. A., "Optimal Reserve Levels for Credit Unions", *Rivista Internazionale Di Scienze Economiche E Commerciali*, 1979, 26, 971-983
- Tirole, J., "Asset Bubbles and Overlapping Generations", *Econometrica*, November 1985, 53(6), 1499-1528
- The Banker, "Shaken and Stirred", *The Banker*, December 1994, 7
- The Banker, "Banking on Building", *The Banker*, May 1995, 7
- Thom, D. R., "House Prices, Inflation and the Mortgage Market", *The Economic and Social Review*, October 1983, 15(1), 57-68
- Thompson, S., "Takeover Activity Among Financial Mutuals : An Analysis of Target Characteristics", *Journal of Banking and Finance*, 1997, 21, 37-53
- Tobin, J., "The Commercial Banking Firm : A Simple Model", *Scandinavian Journal of Economics*, 1982, 84(4), 495-530



Vaitilingam, R. and Tucker, E., *The Financial Times Guide to Using the Financial Pages*, Pitman, London, 1993

Varian, H. R. (Ed.), *Economic and Financial Modelling with Mathematica*, Springer-Verlag, New York, 1993

Walker, M. C. and Chandler, G. G., "On the Allocation of the Net Monetary Benefits of Credit Union Membership", *Review of Social Economy*, October 1977, 35, 159-168

Wallis, K. F., "Seasonal Adjustment and Relations Between Variables", *Journal of the American Statistical Association*, March 1974, 69, 18-31

White, K. J., *SHAZAM User's Reference Manual Version 7.0*, McGraw-Hill, New York, 1993

Wilcox, J. B., "A Model of the Building Society Sector", *Bank of England Discussion Paper*, No. 23, August 1985

Wolfram, S., *Mathematica : A System for Doing Mathematics By Computer*, Addison-Wesley, Redwood City, California, 1988

Wolken, J. D. and Navratil, F. J., "The Economic Impact of the Federal Credit Union Usury Ceiling", *Journal of Finance*, December 1981, 36(5), 1157-1168

Yaari, M. E., "On the Consumer's Lifetime Allocation Process", *International Economic Review*, September 1964, 5(3), 304-317

Yang, J. and Adams, F. G., "The User Cost Estimation of Owner-Occupied Housing", *Journal of Policy Modelling*, 1994, 16(3), 327-333

Zumpano, L. V., Rudolph, P. M. and Cheng, D. C., "The Demand and Supply of Mortgage Funds and Mortgage Loan Terms", *Journal of the American Real Estate and Urban Economics Association*, 1986, 14(1), 91-109

## APPENDIX TO CHAPTER 2

### APPENDIX 2.1 : TRANSFERS OF ENGAGEMENTS (1980-1999)

**Table A2.1.1 : Transfers of Engagements, 1980-1999**

<b>TRANSFER OF ENGAGEMENTS 1999</b>	<b>DATE</b>
Birmingham Midshires BS TE to Halifax PLC	19.04.99
<b>TRANSFER OF ENGAGEMENTS 1997</b>	
Northern Rock BS to Northern Rock PLC	01.10.97
Greenwich BS TE to Portman BS	30.07.97
Bristol & West BS TE to Bank of Ireland PLC	28.07.97
Woolwich BS TE to Woolwich PLC	07.07.97
Halifax BS TE to Halifax PLC	02.06.97
Alliance & Leicester BS TE to Alliance & Leicester PLC	21.04.97
<b>TRANSFER OF ENGAGEMENTS 1996</b>	
West Cumbria BS TE to Cumberland BS	29.09.96
National & Provincial BS TE to Abbey National PLC	05.08.96
City & Metropolitan BS TE to Stroud & Swindon BS	19.04.96
<b>TRANSFER OF ENGAGEMENTS 1995</b>	
Cheltenham & Gloucester BS TE to Lloyds Bank PLC	01.08.95
Leeds Permanent BS TE to Halifax BS	01.08.95
<b>TRANSFER OF ENGAGEMENTS 1994</b>	
North of England BS TE to Northern Rock BS	01.10.94
Tynemouth BS TE to Universal BS	31.10.94
<b>TRANSFERS OF ENGAGEMENTS 1993</b>	
St Pancras BS TE to Portman BS	31.12.93
Bexhill-on-Sea BS TE to Bradford & Bingley BS	29.11.93
Heart of England BS TE to Cheltenham & Gloucester BS	02.10.93
Surrey BS TE to Northern Rock BS	05.07.93
<b>TRANSFERS OF ENGAGEMENTS 1992</b>	
The Haywards Heath BS TE to Yorkshire BS	31.12.92
Mid-Sussex BS TE to Cheltenham & Gloucester BS	01.08.92
Lancastrian BS TE to Northern Rock BS	13.07.92
Town & Country BS TE to Woolwich BS	02.05.92
Southdown BS TE to Leeds Permanent BS	01.04.92
<b>TRANSFERS OF ENGAGEMENTS 1991</b>	
Cheshunt BS TE to Bristol & West BS	30.12.91
Mornington BS TE to Britannia BS	01.10.91
Bedford Crown BS TE to Cheltenham & Gloucester BS	20.07.91
Leamington Spa BS TE to Bradford & Bingley BS	01.07.91
Portsmouth BS TE to Cheltenham & Gloucester BS	30.06.91
Hampshire BS TE to Bradford & Bingley BS	17.06.91
Hendon BS TE to Bradford & Bingley BS	18.03.91
<b>CHANGES OF NAME 1991</b>	
Nationwide Anglia BS to Nationwide BS	01.12.91



<b>TRANSFERS OF ENGAGEMENTS 1990</b>	<b>DATE</b>
Louth Mablethorpe & Sutton BS* TE to Bradford & Bingley BS	26.11.90
Walthamstow BS TE to Cheltenham & Gloucester BS	31.10.90
Eastbourne Mutual BS TE to Sussex County BS which changed its name to Southdown BS	01.10.90
Portman Wessex BS TE to Regency & West of England BS which changed its name to Portman BS	01.10.90
Frome Selwood Permanent BS TE to Stroud & Swindon BS	01.07.90
Peckham BS TE to Cheltenham & Gloucester BS	30.06.90
Sheffield BS TE to Bradford & Bingley BS	15.06.90
Guardian BS TE to Cheltenham & Gloucester BS	16.04.90
Bedford BS TE to Cheltenham & Gloucester BS	08.04.90
<b>CHANGES OF NAME 1990</b>	
Leek United & Midlands BS to Leek BS	01.07.90
Woolwich Equitable BS to Woolwich BS	06.05.90
<b>TRANSFERS OF ENGAGEMENTS 1989</b>	
Portman BS merged with Wessex BS to form Portman Wessex BS	31.07.89
Abbey National BS TE to Abbey National PLC	12.07.89
Regency BS TE to West of England BS which changed its name to Regency & West of England BS	01.05.89
Herts & Essex BS TE to Saffron Walden & Essex BS which changed its name to Saffron Walden Herts & Essex BS	01.04.89
Bury St Edmunds BS TE to Cheltenham & Gloucester BS	01.01.89
<b>CHANGES OF NAME 1989</b>	
Haywards Heath & District BS to Haywards Heath BS	01.03.89
<b>TRANSFERS OF ENGAGEMENTS 1988</b>	
Bolton BS TE to Cheltenham & Gloucester BS	01.10.88
Aid to Thrift BS TE to Cheshunt BS	01.07.88
City of London BS TE to Chelsea BS	01.07.88
Gateway BS TE to Woolwich Equitable BS	31.05.88
North Wilts Ridgeway BS TE to West of England BS	01.03.88
Rowley Regis BS TE to Heart of England BS	01.03.88
Kidderminster Equitable BS* TE to Heart of England BS	01.03.88
Essex Equitable BS TE to Cheltenham & Gloucester BS	29.02.88
<b>CHANGES OF NAME 1988</b>	
Holmesdale Benefit BS to Holmesdale BS	01.09.88
<b>TRANSFERS OF ENGAGEMENTS 1987</b>	
Paddington BS TE to West of England BS	02.11.87
Cardiff BS TE to Cheltenham & Gloucester BS	01.10.87
Chilterns BS TE to Bradford & Bingley BS	05.10.87
City of Derry BS* TE to Nationwide Anglia BS	30.09.87
Nationwide BS TE to Anglia BS to form Nationwide Anglia BS	01.09.87
London Permanent BS TE to Cheltenham & Gloucester BS	01.08.87
Colchester BS TE to Cheltenham & Gloucester BS	01.06.87
Immigrants BS* removed from Register	15.05.87
Harrow BS TE to Birmingham Midshires BS	30.04.87
Hemel Hempstead BS TE to Birmingham Midshires BS	13.04.87
Thrift BS* to Cheshunt BS	13.04.87
Civil Service BS TE to Birmingham Midshires BS	06.04.87
Wishaw Investment BS* TE to Northern Rock BS	02.02.87
United Kingdom BS* TE to Northern Rock BS	05.01.87
Swindon Permanent BS TE to Stroud BS to form Stroud & Swindon BS	02.01.87
<b>CHANGES OF NAME 1987</b>	
Loughborough Permanent BS TE to Loughborough BS	01.05.87

<b>TRANSFERS OF ENGAGEMENTS 1986</b>	<b>DATE</b>
Property Owners BS to Woolwich Equitable BS	01.12.86
Bideford BS to West of England BS	31.10.86
Norwich BS merges with Peterborough BS to form Norwich and Peterborough BS	31.09.86
King Edward BS* TE to Birmingham Midshires BS	15.09.86
Tyldesley BS to Middleton BS to form Lancastrian BS	01.07.86
Birmingham & Bridgwater BS unites with Midshires BS to form Birmingham Midshires BS	30.06.86
Metrogas BS to Midshires BS	24.06.86
North East Globe BS to Universal BS	02.06.86
North of England BS to Sunderland and Shields BS to form North of England BS	02.06.86
Blackheath BS to Britannia BS	02.06.86
Chatham Reliance BS to Herne Bay BS to form Kent Reliance BS	01.04.86
Mitcham and Metropolitan BS to Sussex County BS	01.04.86
Stanley BS to Bradford and Bingley BS	03.02.86
<b>CHANGES OF NAME 1986</b>	
East Surrey BS to Surrey BS	01.07.86
<b>TRANSFERS OF ENGAGEMENTS 1985</b>	
Alliance BS unites with Leicester BS to form Alliance & Leicester	
BS Argyle BS TE To Peterborough BS	
Bristol Economic BS TE to Stroud BS	
British BS* TE to Sun BS*	
Chatham BS TE to Principality BS	
Citizens Regency BS TE to Sussex Mutual BS	
Economic BS* TE to Sun BS*	
Enterprise BS* TE to Sun BS*	
Forresters BS* TE to Bradford and Bingley BS	
Hartlepool & District BS TE to Northern Rock BS	
Haslemere BS TE to National & Provincial BS	
Hibernian BS TE to Bradford & Bingley BS	
Huntly BS TE to Scottish BS	
Kirklees BS* removed from Register	
Manchester Unity of Odd Fellows* TE to Northern Rock BS	
Merseyside BS TE to Bradford & Bingley BS	
North Kent BS TE to Woolwich BS	
Old England BS* TE to Sun BS*	
South Durham BS TE to Sunderland & Shields BS	
South Shields Sun Permanent BS TE to Northern Rock BS	
Waltham Abbey BS TE to Cheltenham & Gloucester BS	
Western Counties BS TE to Ramsbury BS	
<b>CHANGES OF NAME 1985</b>	
Nottingham Oddfellows BS to Nottingham Imperial BS	
<b>CANCELLATION OF REGISTRATION 1985</b>	
Corinthian BS	
Kirklees BS	
Worksop BS was dissolved	



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**TRANSFERS OF ENGAGEMENTS 1984**

Banffshire BS TE to Scottish BS

Boston & Skirbeck BS TE to Leicester BS

Clapham Permanent BS TE to Bradford & Bingley BS

Cotswold BS TE to Cheltenham & Gloucester BS

Country BS TE to Anglia BS

Dover & Folkestone BS TE to Bradford & Bingley BS

Ealing & Acton BS TE to Midshire BS

Glamorgan BS TE to Bradford & Bingley BS

Kent & Canterbury Permanent Benefit BS TE To Chatham

Reliance BS

London Grosvenor BS TE to Woolwich BS

Marble Arch BS TE to Chelsea BS

New Cross BS TE to Woolwich BS

Permanent Scottish BS TE to Scottish BS

**CANCELLATION OF REGISTRATION 1984**

Axminster Seaton & District BS

Dee BS

Hamilton Savings Investment and BS was dissolved

**TRANSFERS OF ENGAGEMENTS 1983**

Anglia BS TE to London & South of England BS to form Anglia BS

Colne BS TE to Britannia BS

Coventry Provident BS TE to Coventry Economic BS to form Coventry BS

Grangemouth BS TE to Woolwich Equitable BS

Hadrian BS TE to Sunderland & Shields BS

Horsham BS TE to Bradford & Bingley BS

Housing and General BE TE to Bradford & Bingley BS

London Commercial BS TE to Nottingham BS

Musselburgh BS TE to Northern Rock BS

North Wilts Equitable BS Unites with Ridgeway BS to form North Wilts & Ridgeway BS

Padiham BS TE to Bradford & Bingley BS

Rugby Provident BS TE to Hinckley BS to form Hinckley & Rugby BS

Severn BS TE to Midshires BS

Shields Commercial BS TE to Sunderland & Shields BS

Stockport Mersey BS TE to Bradford & Bingley BS

Tynemouth Victoria BS TE to Mercantile BS

United Provinces BS TE to Bradford & Bingley BS

Welsh Economic BS TE to Britannia BS

**ADDITIONS TO REGISTER 1983**

Immigrant BS

**CANCELLATION OF REGISTRATION 1983**

Connaught Permanent BS

Simplified BS

Torbay & Devon BS

Victoria Permanent BS

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**TRANSFERS OF ENGAGEMENTS 1982**

Accrington Savings BS TE to Cheshire BS  
Advance BS TE to Darlington BS  
Banner BS TE to Midshires BS  
Birmingham BS Unites with Bridgwater BS to form Birmingham & Bridgwater BS  
Blyth & Morpeth BS TE to Northern Rock BS  
Burnley BS TE to Provincial BS  
City & District Permanent BS TE to Metrogas BS  
Denton BS TE to Britannia BS  
Dorking BS TE to Eastbourne Mutual BS  
Drifffield BS TE to Britannia BS  
Hearts of Oak & Enfield TE to Bradford & Bingley BS  
Kilmarnock BS TE to Northern Rock BS  
Leigh Permanent BS TE to Cheshire BS  
Liverpool BS TE to Midshires BS  
Otley BS TE to Skipton BS  
Over Darwen BS TE to Britannia BS  
Queen Victoria Street BS TE to Metrogas BS  
Saddleworth BS TE to Bradford & Bingley BS  
Shields & Washington BS TE to Northern Rock BS  
Strathclyde BS TE to Scottish BS  
Swansea Park Permanent BS TE To Bradford & Bingley BS  
Sydenham BS TE to Mid-Sussex BS  
Target BS TE to Bradford & Bingley BS  
Wellington (Somerset) and District BS TE to Britannia BS  
Wigan BS TE to Cheshire  
London Goldhawk BS TE to South of England BS to form London & South of England BS  
Newcastle upon Tyne BS TE to Grainger BS to form Newcastle BS  
Oakleaf BS TE to Anglia BS  
Premier Permanent BS TE to City & Metropolitan BS  
St Martins le Grand Permanent Benefit BS TE to Ramsbury BS  
Spread Eagle BS TE to Bradford & Bingley BS  
Stamford BS TE to Peterborough BS  
Stoke-on-Trent BS TE to Britannia BS  
Summers BS TE to Cheshire BS  
Tyne BS TE to North of England BS  
Walker & Byker Industrial Permanent BS TE to Northern Rock BS

**CANCELLATION OF REGISTRATION 1980**

Blackpool BS  
First Salisbury BS  
Longbridge BS  
Wembley BS

**ADDITIONS TO REGISTER 1980**

Ecology BS

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Key : \* : Not a member of the BSA  
TE : Transfer engagements  
BS : Building society

Source : The Building Societies Association web site



## APPENDIX TO CHAPTER 3

### APPENDIX 3.1 : FINANCIAL MATHEMATICS - ANNUITIES

This appendix briefly describes how the nominal annuitised repayment schedule on a mortgage loan is determined.

Consider a mortgage lender who offers the purchaser of a house a mortgage loan of amount  $M$  at a nominal interest rate of  $r_m$  over a period of  $n$  years. The intermediary's problem is then to determine the periodic payment that must be made by the borrower in order that the loan be amortised (i.e. that the principal be repaid in full, including all accrued interest) by the end of the  $n^{\text{th}}$  year. The level of this required payment may be determined by the application of the mathematics of annuities to the problem.

An annuity is an asset which makes a number of either constant or growing periodic payments over time. In the case of a mortgage loan, the present value of the annuity is simply the current level of mortgage debt outstanding held by the borrower, and the annuitised payment is the borrower's regular repayment of interest and principal to the lending institution. In general we will assume that the periodic payment grows at a constant rate of, say,  $g$  (the rate of graduation) over the life of the loan; this turns out to be especially useful when determining the pattern of payments resulting from a graduated payment mortgage (see Section 3.4.3 in the main text).

Assuming that the regular mortgage repayments are made at the end of each period, the first repayment made to the mortgage lender must have grown by a rate of  $g$  over that which would have been paid if the payment was due at the beginning of the period. Denoting  $m_0$  the periodic payment that would be made at the beginning of the current period and  $m_1$  the first end-of-year payment, we may write  $m_1 = m_0(1 + g_1)$ ; indeed, this relationship will hold for the whole duration of the contract period thus giving  $m_t = m_{t-1}(1 + g_t)$ .

With an intertemporally constant payment growth rate, the present value of the mortgage contract,  $M$ , may be written as the discounted sum of the stream of periodic payments over the  $n$  years of the contract, i.e.

$$M = \frac{m_1}{1+r_m} + \frac{m_2}{(1+r_m)^2} + \frac{m_3}{(1+r_m)^3} + \cdots + \frac{m_n}{(1+r_m)^n} \quad (\text{A1.1})$$

or

$$M = \frac{m_0(1+g)}{1+r_m} + \frac{m_0(1+g)^2}{(1+r_m)^2} + \frac{m_0(1+g)^3}{(1+r_m)^3} + \cdots + \frac{m_0(1+g)^n}{(1+r_m)^n} \quad (\text{A1.2})$$

when the repayments are made at the end of each period. Defining  $a = (1+g)/(1+r_m)$  for ease of exposition, we may write equation (A1.2) as

$$M = m_0a + m_0a^2 + m_0a^3 + \cdots + m_0a^n \quad (\text{A1.3})$$

or

$$M = m_0a(1 + a + a^2 + \cdots + a^{n-1}) \quad (\text{A1.4})$$

Multiplying equation (A1.4) by  $a$  and subtracting the result from (A1.4) yields

$$M(1-a) = am_0(1-a^n) \quad (\text{A1.5})$$

or

$$M = \frac{m_0a(1-a^n)}{1-a} \quad (\text{A1.6})$$

Substituting back in for  $a$  in equation (A1.6) gives

$$M = \frac{m_0 \left( \frac{1+g}{1+r_m} \right) \left[ 1 - \left( \frac{1+g}{1+r_m} \right)^n \right]}{1 - \left( \frac{1+g}{1+r_m} \right)} \quad (\text{A1.7})$$



or, finally

$$M = \frac{m_1 \left[ 1 - \left( \frac{1+g}{1+r_m} \right)^n \right]}{r_m - g} \quad (\text{A1.8})$$

Equation (A1.8) is the present value of  $n$  mortgage repayments that begin at the end of the first period at a level of  $m_1$  and grow at a constant rate of  $g$ . To use this formula we must assume that the nominal rate of interest,  $r_m$ , is greater than the rate of growth of the annuitised repayment,  $g$ , otherwise the long hand formulas of equations (A1.1) and (A1.2) must be used. Thus for a mortgage of value  $M$ , interest rate of  $r_m$  and mortgage maturity of  $n$ , the first repayment of a stream of payments growing at a rate of  $g$  will be

$$m_1 = \frac{M}{\left[ 1 - \left( \frac{1+g}{1+r_m} \right)^n \right] / r_m - g} \quad (\text{A1.9})$$

This growing repayment contract is not a particularly common feature of UK mortgage loan contracts. Rather, the majority of mortgage loans have been of the fixed or variable rate type (or indeed a combination of both). Thus, with a zero predetermined growth rate of the annuitised repayments (i.e.  $g = 0$ ), equation (A1.7) becomes<sup>1</sup>

$$M = \frac{m \left( \frac{1}{1+r_m} \right) [1 - (1+r_m)^{-n}]}{1 - \left( \frac{1}{1+r_m} \right)} \quad (\text{A1.10})$$

or

$$M = \frac{m [1 - (1+r_m)^{-n}]}{r_m} \quad (\text{A1.11})$$

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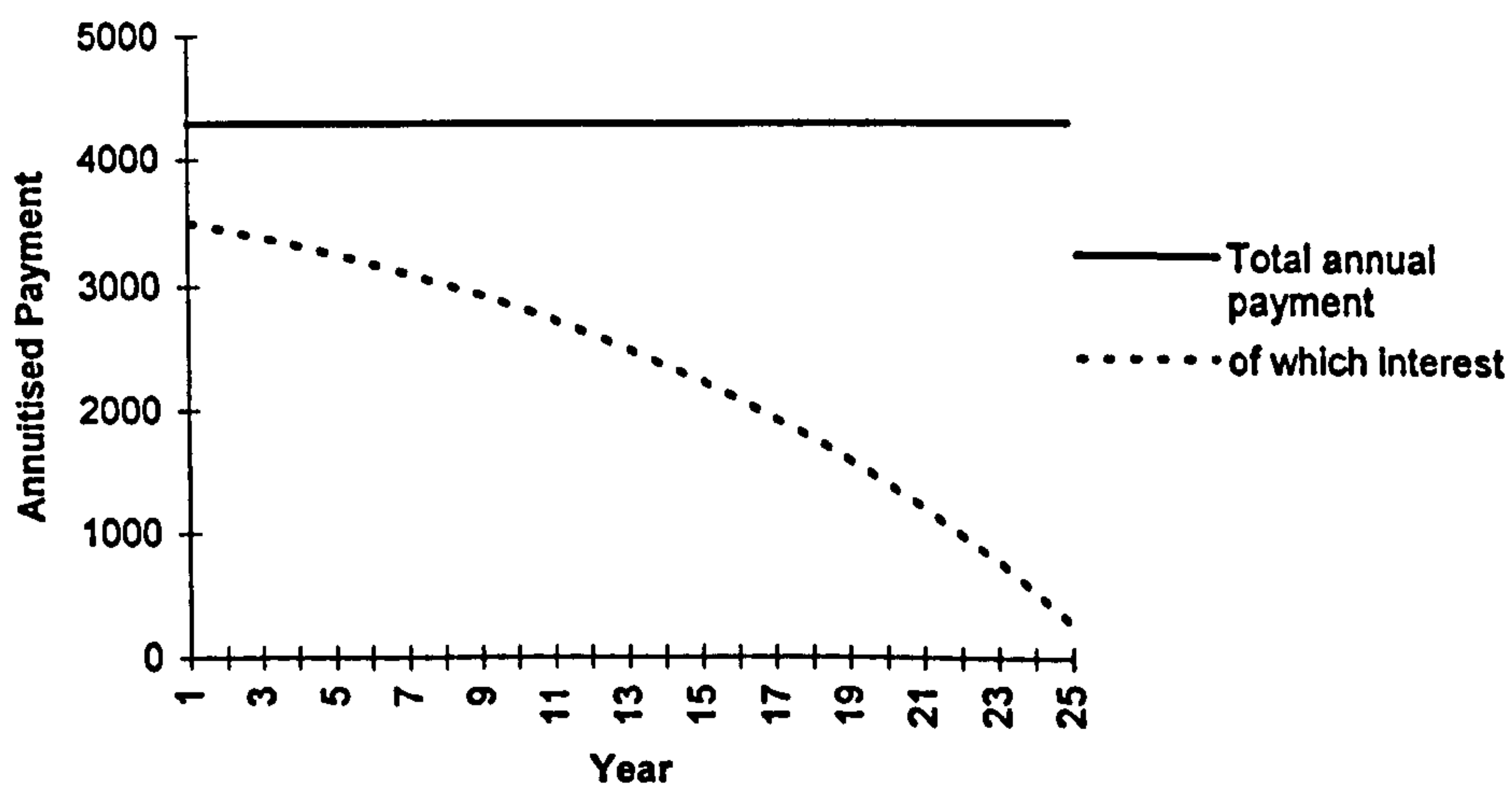
<sup>1</sup> We drop the subscript on the annuitised payment here since with a level payment mortgage all repayments will be identical.

Finally, the constant nominal payment which must be made by the borrower on a mortgage of size  $M$  over a term of  $n$  years at a rate of interest of  $r_m$  is obtained by rearranging equation (A1.11) as

$$m = \frac{M}{\left[1 - (1 + r_m)^{-n}\right] / r_m} \tag{A1.12}$$

With a £50,000 level payment mortgage repayable over a 25 year amortisation period at a nominal interest rate of 7 per cent, the schedule of annual repayments made at the end of each year (calculated according to equation (A1.12)) will look as follows.

Figure A3.1.1 : Annuitised Payment Composed of Interest and Principal (£)





APPENDIX 3.2 : SIMULATIONS OF ALTERNATIVE MORTGAGE DESIGNS

Based on : £50,000 mortgage debt; 25 year amortisation period, annual repayment made at end of year, 3 per cent p.a. real interest rate, £15,000 initial borrower income growing at 2 per cent p.a. in real terms.

Table A3.2.1 : Standard Level Payment Mortgage (LPM) (£)

Year	Outstanding Debt	Annuitised Payment	of which interest payment	of which principal repayment	Interest rate (%)	Inflation rate (%)	Real payment	Income	Nominal payment to income ratio (%)
1	50000.00	4290.53	3500.00	790.53	7	4	4125.51	15900.00	26.98
2	49209.47	4290.53	3444.66	845.86	8	5	3929.05	17013.00	25.22
3	48363.61	4290.53	3385.45	905.07	9	6	3706.65	18374.04	23.35
4	47458.54	4290.53	3322.10	968.43	10	7	3464.16	20027.70	21.42
5	46490.11	4290.53	3254.31	1036.22	11	8	3207.56	22030.47	19.48
6	45453.89	4290.53	3181.77	1108.75	12	9	2942.71	24453.83	17.55
7	44345.14	4290.53	3104.16	1186.37	13	10	2675.19	27388.29	15.67
8	43158.77	4290.53	3021.11	1269.41	12	9	2454.31	30401.00	14.11
9	41889.36	4290.53	2932.26	1358.27	11	8	2272.51	33441.10	12.83
10	40531.09	4290.53	2837.18	1453.35	10	7	2123.84	36450.79	11.77
11	39077.74	4290.53	2735.44	1555.08	9	6	2003.62	39366.86	10.90
12	37522.66	4290.53	2626.59	1663.94	8	5	1908.21	42122.54	10.19
13	35858.72	4290.53	2510.11	1780.42	7	4	1834.82	44649.89	9.61
14	34078.30	4290.53	2385.48	1905.04	8	5	1747.44	47775.38	8.98
15	32173.26	4290.53	2252.13	2038.40	9	6	1648.53	51597.41	8.32
16	30134.86	4290.53	2109.44	2181.09	10	7	1540.68	56241.18	7.63
17	27953.77	4290.53	1956.76	2333.76	11	8	1426.56	61865.30	6.94
18	25620.01	4290.53	1793.40	2497.13	12	9	1308.77	68670.48	6.25
19	23122.89	4290.53	1618.60	2671.92	13	10	1189.79	76910.94	5.58
20	20450.96	4290.53	1431.57	2858.96	12	9	1091.55	85371.14	5.03
21	17592.00	4290.53	1231.44	3059.09	11	8	1010.70	93908.26	4.57
22	14532.92	4290.53	1017.30	3273.22	10	7	944.58	102360.00	4.19
23	11259.70	4290.53	788.18	3502.35	9	6	891.11	110548.80	3.88
24	7757.35	4290.53	543.01	3747.51	8	5	848.68	118287.22	3.63
25	4009.84	4290.53	280.69	4009.84	7	4	816.03	125384.45	3.42

Table A3.2.2 : Standard Variable Rate Mortgage (VRM) (£)

Year	Outstanding Debt	Annuitised Payment	of which interest payment	of which principal repayment	Interest rate (%)	Inflation rate (%)	Real payment	Income	Nominal payment to income ratio (%)
1	50000.00	4290.53	3500.00	790.53	7	4	4125.51	15900.00	26.98
2	49209.47	4673.82	3936.76	737.06	8	5	4280.05	17013.00	27.47
3	48472.42	5059.64	4362.52	697.12	9	6	4371.11	18374.04	27.54
4	47775.29	5446.63	4777.53	669.10	10	7	4397.59	20027.70	27.20
5	47106.20	5833.53	5181.68	651.85	11	8	4361.10	22030.47	26.48
6	46454.34	6219.25	5574.52	644.73	12	9	4265.55	24453.83	25.43
7	45809.61	6602.74	5955.25	647.49	13	10	4116.89	27388.29	24.11
8	45162.12	6229.54	5419.45	810.09	12	9	3563.48	30401.00	20.49
9	44352.04	5875.38	4878.72	996.66	11	8	3111.93	33441.10	17.57
10	43355.38	5541.54	4335.54	1206.00	10	7	2743.10	36450.79	15.20
11	42149.38	5229.00	3793.44	1435.56	9	6	2441.88	39366.86	13.28
12	40713.82	4938.46	3257.11	1681.35	8	5	2196.38	42122.54	11.72
13	39032.47	4670.27	2732.27	1938.00	7	4	1997.21	44649.89	10.46
14	37094.47	4922.25	2967.56	1954.69	8	5	2004.73	47775.38	10.30
15	35139.78	3926.18	3162.58	763.60	9	6	1508.54	51597.41	7.61
16	34376.18	5594.56	3437.62	2156.95	10	7	2008.95	56241.18	9.95
17	32219.23	5818.85	3544.12	2274.73	11	8	1934.71	61865.30	9.41
18	29944.50	6027.91	3593.34	2434.57	12	9	1838.74	68670.48	8.78
19	27509.93	6220.29	3576.29	2644.00	13	10	1724.93	76910.94	8.09
20	24865.92	6048.03	2983.91	3064.12	12	9	1538.68	85371.14	7.08
21	21801.80	5898.92	2398.20	3500.72	11	8	1389.58	93908.26	6.28
22	18301.08	5773.46	1830.11	3943.35	10	7	1271.05	102360.00	5.64
23	14357.73	5672.09	1292.20	4379.89	9	6	1178.05	110548.80	5.13
24	9977.84	5595.26	798.23	4797.04	8	5	1106.76	118287.22	4.73
25	5180.80	5543.46	362.66	5180.80	7	4	1054.33	125384.45	4.42



Table A3.2.3 : Dual Rate Variable Rate Mortgage (DRVRM) (£)

Year	Outstanding Debt	Annuitised Payment	<i>of which</i> interest payment	<i>of which</i> principal payment	Payment rate (%)	Debit Rate (%)	Inflation rate (%)	Real payment	Income	Nominal payment to income ratio (%)
1	50000.00	5090.31	3500.00	1590.31	9	7	4	4894.53	15900.00	32.01
2	48409.69	5387.99	3872.77	1515.21	10	8	5	4934.05	17013.00	31.67
3	46894.48	5672.88	4220.50	1452.38	11	9	6	4900.89	18374.04	30.87
4	45442.10	5944.30	4544.21	1400.09	12	10	7	4799.42	20027.70	29.68
5	44042.00	6201.75	4844.62	1357.12	13	11	8	4636.37	22030.47	28.15
6	42684.88	6444.82	5122.19	1322.63	14	12	9	4420.26	24453.83	26.36
7	41362.25	6673.23	5377.09	1296.14	15	13	10	4160.84	27388.29	24.37
8	40066.10	6195.07	4807.93	1387.13	14	12	9	3543.76	30401.00	20.38
9	38678.97	5748.02	4254.69	1493.33	13	11	8	3044.48	33441.10	17.19
10	37185.63	5332.05	3718.56	1613.49	12	10	7	2639.40	36450.79	14.63
11	35572.15	4946.85	3201.49	1745.36	11	9	6	2310.11	39366.86	12.57
12	33826.79	4591.86	2706.14	1885.72	10	8	5	2042.23	42122.54	10.90
13	31941.08	4266.26	2235.88	2030.38	9	7	4	1824.44	44649.89	9.55
14	29910.69	4389.79	2392.86	1996.94	10	8	5	1787.87	47775.38	9.19
15	27913.76	4497.49	2512.24	1985.25	11	9	6	1728.05	51597.41	8.72
16	25928.50	4588.93	2592.85	1996.08	12	10	7	1647.84	56241.18	8.16
17	23932.42	4663.68	2632.57	2031.12	13	11	8	1550.63	61865.30	7.54
18	21901.30	4721.26	2628.16	2093.11	14	12	9	1440.16	68670.48	6.88
19	19808.19	4761.10	2575.06	2186.04	15	13	10	1320.29	76910.94	6.19
20	17622.15	4531.67	2114.66	2417.01	14	12	9	1152.90	85371.14	5.31
21	15205.14	4323.04	1672.57	2650.48	13	11	8	1018.36	93908.26	4.60
22	12554.66	4133.43	1255.47	2877.96	12	10	7	909.99	102360.00	4.04
23	9676.70	3959.83	870.90	3088.93	11	9	6	822.43	110548.80	3.58
24	6587.77	3795.81	527.02	3268.79	10	8	5	750.82	118287.22	3.21
25	3318.98	3617.69	232.33	3385.36	9	7	4	688.06	125384.45	2.89

Table A3.2.4 : Graduated Payment Mortgage (GPM) (£)

Year	Outstanding Debt	Annuitised Payment	<i>of which</i> interest payment	<i>of which</i> principal repayment	Interest rate (%)	Inflation rate (%)	Real payment	Income	Nominal payment to income ratio (%)
1	50000.00	2947.99	3500.00	-552.01	7	4	2834.60	15900.00	18.54
2	50552.01	3065.91	3538.64	-472.73	7	4	2834.60	16854.00	18.19
3	51024.75	3188.54	3571.73	-383.19	7	4	2834.60	17865.24	17.85
4	51407.94	3316.08	3598.56	-282.47	7	4	2834.60	18937.15	17.51
5	51690.41	3448.73	3618.33	-169.60	7	4	2834.60	20073.38	17.18
6	51860.01	3586.68	3630.20	-43.52	7	4	2834.60	21277.79	16.86
7	51903.54	3730.14	3633.25	96.90	7	4	2834.60	22554.45	16.54
8	51806.64	3879.35	3626.46	252.88	7	4	2834.60	23907.72	16.23
9	51553.76	4034.52	3608.76	425.76	7	4	2834.60	25342.18	15.92
10	51127.99	4195.90	3578.96	616.94	7	4	2834.60	26862.72	15.62
11	50511.05	4363.74	3535.77	827.97	7	4	2834.60	28474.48	15.33
12	49683.08	4538.29	3477.82	1060.47	7	4	2834.60	30182.95	15.04
13	48622.61	4719.82	3403.58	1316.24	7	4	2834.60	31993.92	14.75
14	47306.37	4908.61	3311.45	1597.17	7	4	2834.60	33913.56	14.47
15	45709.20	5104.96	3199.64	1905.31	7	4	2834.60	35948.37	14.20
16	43803.89	5309.16	3066.27	2242.89	7	4	2834.60	38105.28	13.93
17	41561.00	5521.52	2909.27	2612.25	7	4	2834.60	40391.59	13.67
18	38948.75	5742.38	2726.41	3015.97	7	4	2834.60	42815.09	13.41
19	35932.78	5972.08	2515.29	3456.79	7	4	2834.60	45383.99	13.16
20	32475.99	6210.96	2273.32	3937.64	7	4	2834.60	48107.03	12.91
21	28538.35	6459.40	1997.68	4461.72	7	4	2834.60	50993.45	12.67
22	24076.63	6717.78	1685.36	5032.41	7	4	2834.60	54053.06	12.43
23	19044.22	6986.49	1333.10	5653.39	7	4	2834.60	57296.24	12.19
24	13390.82	7265.95	937.36	6328.59	7	4	2834.60	60734.02	11.96
25	7062.23	7556.59	494.36	7062.23	7	4	2834.60	64378.06	11.74



Table A3.2.5 : Price Level Adjusted Mortgage (PLAM) (£)

Year	Outstanding Debt	Principal Revaluation	Annuitised Payment	of which interest payment	of which principal payment	Interest rate (%)	Inflation rate (%)	Real payment	Income	Nominal payment to income ratio (%)
1	50000.00	2000.00	2986.25	1560.00	-573.75	7	4	2871.39	15900.00	18.78
2	50573.75	2528.69	3135.56	1593.07	-986.20	8	5	2871.39	17013.00	18.43
3	51559.95	3093.60	3323.70	1639.61	-1409.51	9	6	2871.39	18374.04	18.09
4	52969.46	3707.86	3556.35	1700.32	-1851.83	10	7	2871.39	20027.70	17.76
5	54821.29	4385.70	3840.86	1776.21	-2321.05	11	8	2871.39	22030.47	17.43
6	57142.33	5142.81	4186.54	1868.55	-2824.82	12	9	2871.39	24453.83	17.12
7	59967.16	5996.72	4605.19	1978.92	-3370.44	13	10	2871.39	27388.29	16.81
8	63337.60	5700.38	5019.66	2071.14	-2751.86	12	9	2871.39	30401.00	16.51
9	66089.46	5287.16	5421.23	2141.30	-2007.22	11	8	2871.39	33441.10	16.21
10	68096.68	4766.77	5800.72	2185.90	-1151.95	10	7	2871.39	36450.79	15.91
11	69248.63	4154.92	6148.76	2202.11	-208.26	9	6	2871.39	39366.86	15.62
12	69456.89	3472.84	6456.20	2187.89	795.47	8	5	2871.39	42122.54	15.33
13	68661.42	2746.46	6714.45	2142.24	1825.76	7	4	2871.39	44649.89	15.04
14	66835.67	3341.78	7050.17	2105.32	1603.07	8	5	2871.39	47775.38	14.76
15	65232.60	3913.96	7473.18	2074.40	1484.83	9	6	2871.39	51597.41	14.48
16	63747.77	4462.34	7996.31	2046.30	1487.66	10	7	2871.39	56241.18	14.22
17	62260.11	4980.81	8636.01	2017.23	1637.97	11	8	2871.39	61865.30	13.96
18	60622.14	5455.99	9413.25	1982.34	1974.92	12	9	2871.39	68670.48	13.71
19	58647.22	5864.72	10354.58	1935.36	2554.50	13	10	2871.39	76910.94	13.46
20	56092.73	5048.35	11286.49	1834.23	4403.91	12	9	2871.39	85371.14	13.22
21	51688.81	4135.11	12189.41	1674.72	6379.59	11	8	2871.39	93908.26	12.98
22	45309.23	3171.65	13042.67	1454.43	8416.59	10	7	2871.39	102360.00	12.74
23	36892.63	2213.56	13825.23	1173.19	10438.48	9	6	2871.39	110548.80	12.51
24	26454.15	1322.71	14516.49	833.31	12360.47	8	5	2871.39	118287.22	12.27
25	14093.68	563.75	15097.15	439.72	14093.68	7	4	2871.39	125384.45	12.04

Table A3.2.6 : Constant Payment Rate Variable Rate Mortgage (CPVRM) (£)

Year	Outstanding Debt	Annuitised Payment	of which interest payment	of which principal payment	Payment rate (%)	Debit Rate (%)	Inflation rate (%)	Real payment	Income	Nominal payment to income ratio (%)
1	50000.00	3547.62	3500.00	47.62	9	7	4	3411.18	15900.00	22.31
2	49952.38	3620.09	3996.19	-376.10	10	8	5	3315.10	17013.00	21.28
3	50328.47	3731.19	4529.56	-798.37	11	9	6	3223.44	18374.04	20.31
4	51126.84	3884.13	5112.68	-1228.55	12	10	7	3136.04	20027.70	19.39
5	52355.40	4083.52	5759.09	-1675.58	13	11	8	3052.80	22030.47	18.54
6	54030.97	4335.58	6483.72	-2148.13	14	12	9	2973.62	24453.83	17.73
7	56179.10	4648.54	7303.28	-2654.74	15	13	10	2898.42	27388.29	16.97
8	58833.85	5033.01	7060.06	-2027.05	14	12	9	2879.03	30401.00	16.56
9	60860.89	5398.31	6694.70	-1296.39	13	11	8	2859.25	33441.10	16.14
10	62157.28	5735.25	6215.73	-480.48	12	10	7	2838.98	36450.79	15.73
11	62637.77	6034.67	5637.40	397.27	11	9	6	2818.11	39366.86	15.33
12	62240.50	6287.78	4979.24	1308.54	10	8	5	2796.49	42122.54	14.93
13	60931.96	6486.56	4265.24	2221.32	9	7	4	2773.94	44649.89	14.53
14	58710.64	6624.05	4696.85	1927.20	10	8	5	2697.84	47775.38	13.86
15	56783.43	6836.09	5110.51	1725.59	11	9	6	2626.61	51597.41	13.25
16	55057.85	7130.24	5505.78	1624.46	12	10	7	2560.40	56241.18	12.68
17	53433.39	7517.55	5877.67	1639.88	13	11	8	2499.52	61865.30	12.15
18	51793.52	8013.59	6215.22	1798.36	14	12	9	2444.44	68670.48	11.67
19	49995.15	8640.15	6499.37	2140.78	15	13	10	2395.97	76910.94	11.23
20	47854.37	9428.15	5742.52	3685.62	14	12	9	2398.61	85371.14	11.04
21	44168.75	10201.87	4858.56	5343.31	13	11	8	2403.20	93908.26	10.86
22	38825.44	10949.23	3882.54	7066.69	12	10	7	2410.52	102360.00	10.70
23	31758.75	11662.09	2858.29	8803.80	11	9	6	2422.13	110548.80	10.55
24	22954.95	12345.29	1836.40	10508.89	10	8	5	2441.92	118287.22	10.44
25	12446.06	13068.37	871.22	12197.14	9	7	4	2485.53	125384.45	10.42



# APPENDIX TO CHAPTER 4

## APPENDIX 4.1 : VARIABLES USED IN THE ANALYSIS

Table A4.1.1 : Variable Definitions

Variable Name	Variable Definition	Source
<i>AIIJ</i>	Personal disposable income (£m)	Economic Trends
<i>ALDO</i>	Personal gross financial assets (£m)	Financial Statistics
<i>ARR</i>	Loans over 6 months in arrear at end period as a proportion of the number of outstanding mortgage loans	Housing Finance
<i>AYR</i>	Loan to income ratio for first time buyers	Housing Finance
<i>DSR</i>	Debt service ratio (debt repayments as a percentage of personal disposable income)	Financial Statistics and Economic Trends
<i>DSTK</i>	Stock of owner-occupied dwellings (thousands)	Housing and Construction Statistics Part 2
<i>POPN</i>	Percentage of population aged 25-29, mid-year estimates	Office for National Statistics, Population Estimates
<i>PAHM</i>	Mix adjusted house price index (1990=100)	Housing and Construction Statistics Part 2
<i>POSS</i>	Number of properties taken into possession in period as a proportion of the number of outstanding mortgage loans	Housing Finance
<i>r<sub>m</sub></i>	MIRAS-adjusted basic rate on mortgages (per cent)	Financial Statistics
<i>R(UC)</i>	Real user cost of owner occupied housing (per cent)	Various sources (see Chapter 6)
<i>UNEW</i>	Unwithdrawn equity (ratio of the average house price to the average mortgage loan size) (index)	Housing and Construction Statistics Part 2, Housing Finance and Financial Statistics
<i>UR</i>	Unemployment rate (per cent)	Economic Trends
<i>ZLVF</i>	Loan to value ratio for first time buyers (per cent)	Housing Finance

Table A4.1.2 : Original Periodicity of Interpolated Variables

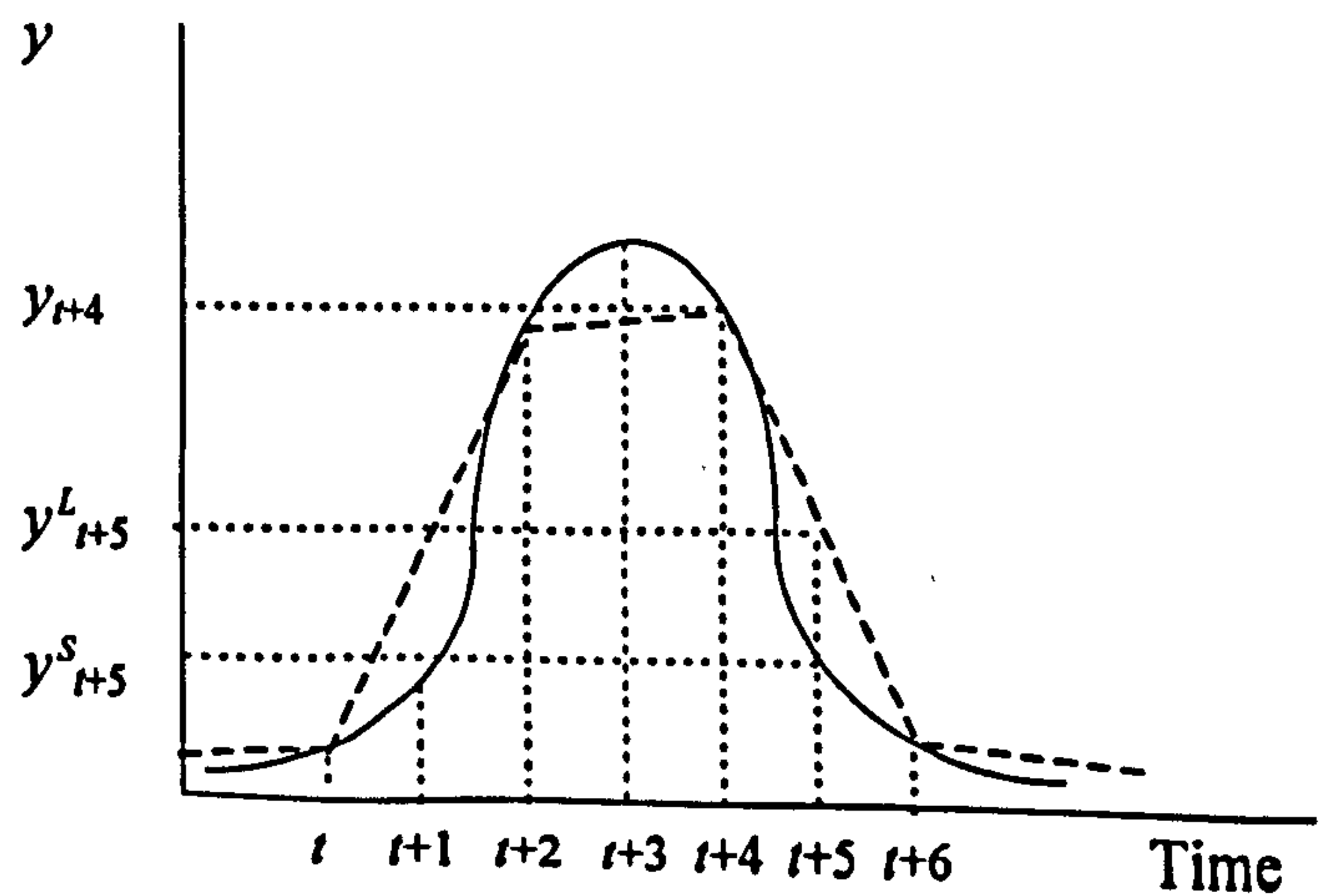
Variable Definition	Variable Name	Availability
Loans over 6 months in arrear	<i>ARR</i>	Annual and Bi-annual
Stock of owner occupied dwellings	<i>DSTK</i>	Annual
Proportion of population aged 25-29	<i>POPN</i>	Annual
Properties taken into possession	<i>POSS</i>	Annual and Bi-annual

The EXPAND procedure in the econometrics package SAS was used to ‘expand’ this non-quarterly data from its lower frequency interval (either annually or bi-annually) to the higher frequency interval (quarterly) by fitting a cubic spline curve to the data. The spline curve is simply a segmented function consisting of third degree (or cubic) polynomials joined together; the advantage of using such a function for interpolation

purposes is that the curve representing each distinct piece or segment is a continuous function and need not necessarily be a straight line (unlike simple ‘averaging’ interpolation techniques, which are essentially variants of the methodology of piecewise linear regression)<sup>1</sup>. The procedure guarantees that the first and second derivatives will be continuous in contrast to the discontinuous derivatives which result from the fitting of straight line segments between the original data points.

To see the effect of using this technique, consider the case where for a particular stock variable ( $y_t$ ) only bi-annual data is available. Denoting quarterly time periods by  $t$  and assuming that the sample begins in period  $t$  and ends in period  $t+n$ , data points for this bi-annual variable will be observed at time periods  $t, t+2, t+4, \dots, t+n$ , interpolation then being required for periods  $t+1, t+3, t+5, \dots, t+n-1$ . This is illustrated below in Figure A4.1.1. Using standard linear interpolation, we would estimate the data point at time  $t+5$ , for example, to be simply  $(y_{t+4} + y_{t+6})/2$  (labelled  $y_{t+5}^L$  in the figure). Thus the interpolated data point at  $t+5$  is clearly independent of the actual data point at, say,  $t+2$ . However, the estimation of a cubic spline function looks beyond the actual data points to each side of the required interpolated data point, and thus  $t+2$  will be important (albeit to a lesser extent than  $t+4$  or  $t+6$ ) in determining the interpolated figure at time  $t+5$  (a smooth spline curve is fitted to the data with  $y_{t+5}^S$  becoming the desired interpolated data point).

**Figure A4.1.1 : A Comparison between Spline and Linear Interpolation Techniques**

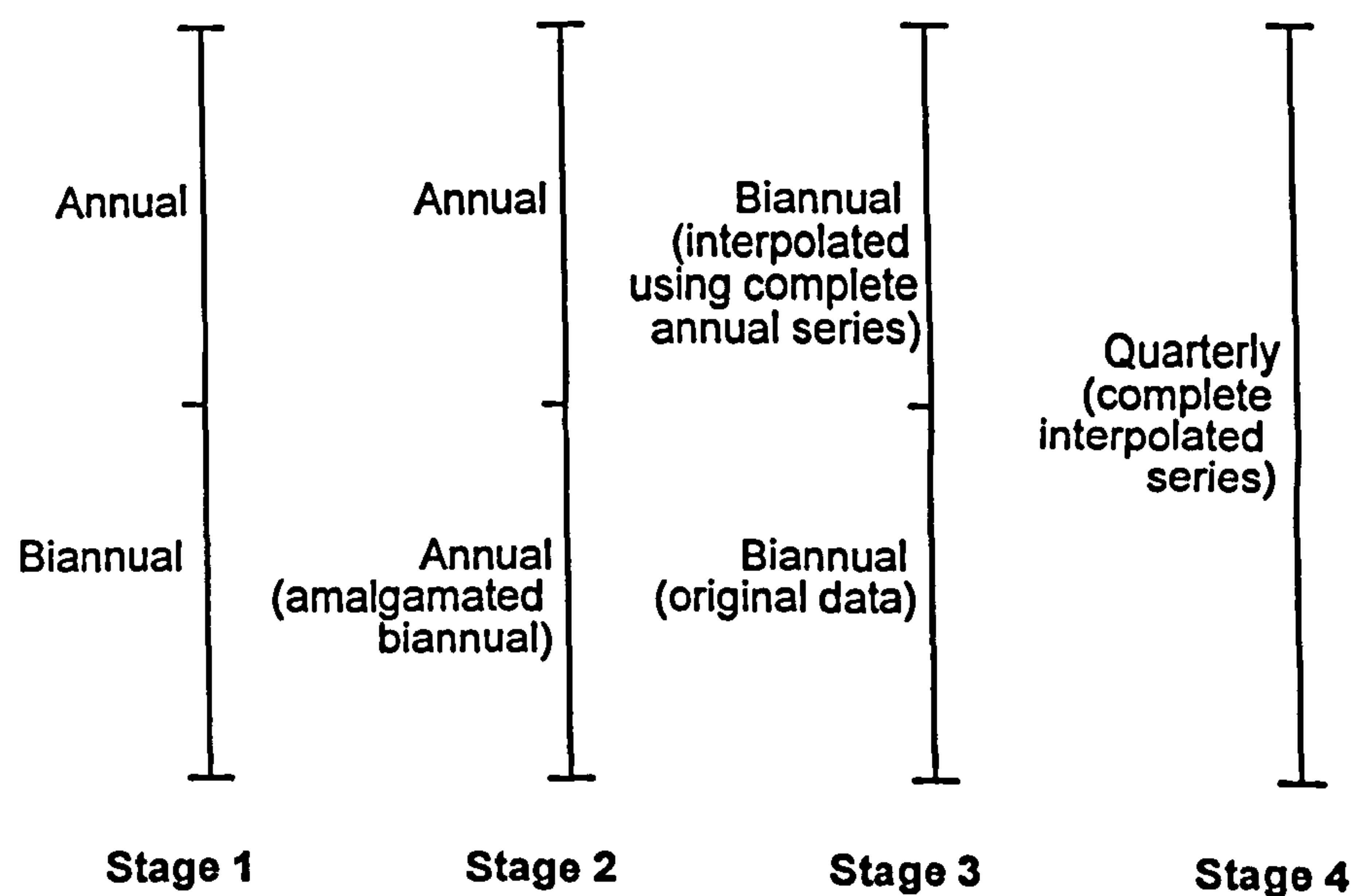


<sup>1</sup> For a discussion of the theory and estimation of spline functions see Suits, Mason and Chan (1978).



Attention must be drawn to the technique used to interpolate those series in which data frequencies are combined. Consider, for example, a time series for which only annual data is available for the first half of the sample period with bi-annual data becoming available during the second period (such as the arrears and possessions series discussed in the main text). This situation is shown in Stage 1 of Figure A4.1.2 below.

**Figure A4.1.2 : Spline Interpolation of Multiple-Frequency-Interval Data**



Using straight-line estimation techniques, it would be valid simply to interpolate a quarterly series from the annual portion of the data sample and then separately interpolate a quarterly series from the biannual data, following which the two quarterly series may be combined.

However, this method will be inefficient when using the cubic spline estimation technique since only a subsample of the whole data set would be used when estimating any interpolated figure. Instead, the procedure set out below is followed. Firstly, the bi-annual observations in the data series are aggregated such that an annual series is constructed for the *whole* of the sample period; no special interpolation procedures are required for this, just a perception of whether the biannual data

represents end of period stock values (in which case the annual figure is taken to be the value for the second half of the year), flow values over the period (in which case the annual figure will be represented by the summation of the two bi-annual figures), or period averages (where the annual figure will be represented by a simple average of the two bi-annual figures). This *complete* annual series is then interpolated to achieve a bi-annual series. Then, the interpolated portion of this complete bi-annual series is combined with the original raw bi-annual data to achieve a complete bi-annual series (Stage 3). Finally, this whole bi-annual time series is then interpolated to achieve the quarterly data series as required (Stage 4). This method of interpolation for series exhibiting multiple frequencies, despite being tedious, ensures that all available raw data is used at each stage of the procedure, thus ensuring no loss of information or efficiency in the interpolation of 'missing' data points.



# APPENDIX 4.2 : UNIT ROOT TESTS

Notation :    A : Akaike Information Criterion (1974)  
              S : Schwartz Criterion (1978)  
              H : Hannan-Quinn Criterion (1979)  
              L : LM Test Decision<sup>2</sup>  
              ln : Denotes the natural logarithm of a variable  
              R : Denotes a real variable

All variable names and definitions are given in Table A4.1.1 of Appendix 4.1. The variables in levels in the tables below appear in the form they take in the cointegrating model as discussed in the main text of the chapter. The shaded cells in the tables below indicate the rejection of the null hypothesis of a unit root at the 5 per cent level, the ADF *t*-statistic being greater than the critical value. The tables would suggest that the ADF *t*-tests are strongly influenced by the choice of lag length.

Table A4.2.1 : ADF Unit Root *t*-Tests (with constant, no time trend) : Levels

Variable	ADF (A)	ADF (S)	ADF (H)	ADF (L)	A	S	H	L
lnR(AIJJ)	-0.5394	-0.7093	-0.7093	-0.6432	8	2	2	1
lnR(ALDO)	0.3445	0.3445	0.3445	0.3445	1	1	1	1
lnARR	-0.7824	-1.0844	-1.0844	-1.0844	6	4	4	4
lnAYR	-1.6010	-1.3083	-1.6010	-1.3083	6	1	6	1
lnDSR	-1.6726	-1.5221	-1.6726	-1.5908	6	0	6	1
lnDSTK	-1.7871	-1.7272	-1.7272	-1.7871	7	3	3	7*
lnINFL	-0.3833	-0.7988	-0.3833	-0.3833	8	5	8	8
lnR(PAHM)	-2.3118	-3.0647	-2.3118	-2.7418	4	2	4	3
lnPOPN	-1.8938	-1.8938	-1.8938	-1.8938	8	8	8	8*
lnPOSS	-0.9594	-1.0085	-1.0085	-0.9594	8	4	4	8*
R(r <sub>m</sub> )	-1.0672	-1.0975	-1.2781	-1.0975	8	4	7	4
R(UC)	-3.7136	-3.7136	-3.7136	-3.7136	1	1	1	1
lnUNEW	-2.9916	-2.9916	-2.9916	-2.9916	2	2	2	2
lnUR	-2.4837	-2.9714	-2.9714	-2.6581	7	2	2	1*

Critical value at the 5 per cent level of significance is -2.89

<sup>2</sup> This is the first lag for which the null hypothesis of no autocorrelation in the residual series cannot be rejected. Under the null hypothesis the LM statistic will follow a  $\chi^2$  with 4 degrees of freedom; at the 5 per cent level of significance the critical value is 9.49. If serial correlation remains in the model for all lags of up to order 8, then the chosen lag length is that with the lowest LM test statistic and is indicated by a \*.

**Table A4.2.2 : ADF Unit Root *t*-Tests (with constant and time trend) : Levels**

Variable	ADF (A)	ADF (S)	ADF (H)	ADF (L)	A	S	H	L
$\ln R(AIJJ)$	-3.5838	-2.6991	-3.5838	-2.6991	6	2	6	2
$\ln R(ALDO)$	-2.2558	-2.2558	-2.2558	-2.2558	1	1	1	1
$\ln ARR$	-2.2817	-2.4845	-2.4845	-2.4845	6	4	4	4
$\ln AYR$	-1.9052	-1.6570	-1.9052	-1.6570	6	1	6	1
$\ln DSR$	-2.6206	-1.5098	-2.6206	-1.5098	6	0	6	0
$\ln DSTK$	-2.5262	-2.5262	-2.5262	-2.5262	3	3	3	3*
$\ln INFL$	-1.8908	-2.3546	-1.8908	-1.8908	8	5	8	8*
$\ln R(PAHM)$	-2.7909	-4.1585	-4.1585	-4.1585	4	2	2	2
$\ln POPN$	-3.8395	-3.8395	-3.8395	-3.8395	8	8	8	8*
$\ln POSS$	-3.6895	-4.0322	-3.8970	-3.8970	8	3	5	5
$R(r_m)$	-2.2492	-2.0306	-2.6473	-2.6473	7	4	6	6
$R(UC)$	-5.6807	-5.6807	-5.6807	-5.6807	1	1	1	1
$\ln UNEW$	-4.4045	-4.4045	-4.4045	-4.4045	2	2	2	2
$\ln UR$	-1.7725	-2.8615	-2.8615	-2.1613	7	2	2	4*

Critical value at the 5 per cent level of significance is -3.46

**Table A4.2.3 : ADF Unit Root *t*-Tests (with constant, no time trend) : Differences**

Variable	ADF (A)	ADF (S)	ADF (H)	ADF (L)	A	S	H	L
$\Delta \ln R(AIJJ)$	-3.5893	-5.7655	-5.7655	-12.0234	7	1	1	0
$\Delta \ln R(ALDO)$	-7.6317	-7.6317	-7.6317	-7.6317	0	0	0	0
$\Delta \ln ARR$	-3.3034	-3.0943	-3.0943	-3.0943	5	3	3	3
$\Delta \ln AYR$	-3.6956	-6.7294	-2.8566	-6.7294	8	0	5	0
$\Delta \ln DSR$	-3.1244	-8.5645	-3.1244	-8.5645	5	0	5	0
$\Delta \ln DSTK$	-1.8544	-1.6622	-1.6622	-1.6622	6	2	2	2
$\Delta \ln INFL$	-3.1891	-4.5956	-3.1891	-4.5767	8	4	8	7
$\Delta \ln R(PAHM)$	-3.8128	-3.8128	-3.8128	-3.8128	3	3	3	3
$\Delta \ln POPN$	-2.0432	-2.0432	-2.0432	-2.0386	7	7	7	8*
$\Delta \ln POSS$	-3.8299	-4.6671	-4.6671	-4.4258	8	3	3	6*
$\Delta R(r_m)$	-4.4583	-6.7064	-4.1543	-3.6845	7	3	6	5
$\Delta R(UC)$	-6.2225	-5.9718	-6.2225	-5.3955	2	1	2	0
$\Delta \ln UNEW$	-4.1621	2.9223	-3.8423	-3.9319	4	1	3	0
$\Delta \ln UR$	-4.3221	-4.3221	-4.3221	-3.5641	6	6	6	2

Critical value at the 5 per cent level of significance is -2.89



Table A4.2.4 : ADF Unit Root *t*-Tests (with constant and time trend) : Differences

Variable	ADF (A)	ADF (S)	ADF (H)	ADF (L)	A	S	H	L
$\Delta \ln R(AIJ)$	-3.5756	-5.7422	-5.7422	-11.9694	7	1	1	0
$\Delta \ln R(ALDO)$	-7.7780	-7.7780	-7.7780	-7.7780	0	0	0	0
$\Delta \ln ARR$	-3.2528	-3.0316	-3.0316	-3.0316	5	3	3	3
$\Delta \ln AYR$	-3.7642	-6.7162	-2.8716	-2.8716	8	0	5	5
$\Delta \ln DSR$	-3.2121	-8.5913	-3.2121	-6.6127	5	0	5	1
$\Delta \ln DSTK$	-2.1152	-1.9757	-1.9757	-1.9757	6	2	2	2
$\Delta \ln INFL$	-3.3228	-6.8676	-3.3228	-4.7362	8	3	8	7
$\Delta \ln R(PAHM)$	-3.8895	-3.8895	-3.8895	-3.8895	3	3	3	3
$\Delta \ln POPN$	-2.0299	-2.0299	-2.0299	-2.0225	7	7	7	8*
$\Delta \ln POSS$	-3.7647	-4.6266	-4.6266	-4.3769	8	3	3	6*
$\Delta R(r_m)$	-4.4167	-6.6677	-4.1129	-3.6442	7	3	6	5
$\Delta R(UC)$	-6.1963	-5.9431	-6.1963	-5.3689	2	1	2	0
$\Delta \ln UNEW$	-4.2814	-2.8521	-4.2814	-3.9317	4	1	4	0
$\Delta \ln UR$	-4.2782	-4.2782	-4.2782	-3.5255	6	6	6	2

Critical value at the 5 per cent level of significance is -3.46

The tables above suggest that the level variables  $\ln UNEW$ ,  $R(UC)$ ,  $\ln R(PAHM)$ ,  $\ln POPN$  and  $\ln POSS$  could be stationary<sup>3</sup> and that the first differences of  $\ln DSTK$ ,  $\ln POPN$  and  $\ln ARR$  could be non-stationary at the 5 per cent level of significance. For each of these variables, the autocorrelation function and time series plots are examined upon which it is concluded that the level variables are integrated of order 1 and their differences of order zero, suggesting that all of the level series can be incorporated in the cointegrating relationships presented in the main text.

<sup>3</sup> The results are suggestive of trend stationarity, particularly in the cases of latter three variables.

## APPENDIX 4.3 : RESULTS FROM COINTEGRATING REGRESSIONS

The estimation results for the three cointegrating equations of real house prices, arrears and possessions are presented below as specified both with and without a constant term. All are estimated over both the full sample period and a sample period restricted to the same length as that of B&J<sup>4</sup>. The results are presented in the tables below for the following estimation techniques : Ordinary Least Squares (OLS), Park's (1992) Canonical Cointegrating Regression (CCR) estimator, Phillips and Hansen's (1990) Fully Modified estimator and Phillips' (1993) Fully Modified estimator.

As discussed in Section 4.3.2.1, the CCR estimator of Park (1992) produces superior results to the other estimators, and this is confirmed in the tables below by a comparison of the magnitude and signing of the CCR coefficients with the super-consistent OLS estimates. *t*-statistics are reported in parentheses, although for the OLS results the standard *t*-statistics will be invalid.

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<sup>4</sup> The full sample period begins in 1971Q1 for real house prices and 1969Q4 for arrears and possessions, and for all series ends in 1995Q4. The restricted sample is defined as 1971Q1-1990Q3 for the house price equation and 1970Q3-1991Q2 for the arrears and possessions equations (for data availability reasons the start dates of the restricted samples are not quite identical to those of B&J).



- Full Sample Period Estimations

**Table A4.3.1 : Estimates of the Long Run Cointegrating Real House Price Equation With Constant; Dependent Variable :  $\ln R(PAHM)$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
Constant	-14.4317 (-9.95)	-15.7793 (-9.79)	-22.2108 (-12.71)	-58.8114
$\ln R(AIJJ)$	0.2833 (0.77)	-0.3750 (-0.90)	-1.2929 (-3.15)	1.0900
$\ln R(ALDO)$	0.2653 (3.15)	0.3118 (3.63)	0.0562 (0.57)	-1.6183
$\ln DSTK$	0.8196 (1.80)	1.6619 (2.93)	3.4023 (6.50)	7.2563
$\ln POPN$	1.6688 (6.67)	1.6365 (7.94)	3.4111 (11.56)	1.5793
$R(UC)$	0.0046 (1.02)	0.0104 (1.67)	0.0036 (0.70)	-0.0919
$\ln INFL$	0.0942 (2.95)	0.1312 (5.25)	0.1451 (4.03)	-1.2018
$\ln POSS$	-0.1878 (-6.69)	-0.2256 (-6.36)	-0.2934 (-9.07)	-0.9675

*t*-statistics in parentheses

**Table A4.3.2 : Estimates of the Long Run Cointegrating Real House Price Equation Without Constant; Dependent Variable :  $\ln R(PAHM)$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
$\ln R(AIJJ)$	1.3611 (2.71)	0.1858 (0.40)	0.2166 (0.31)	-1.7349
$\ln R(ALDO)$	0.2554 (2.12)	0.5664 (4.56)	-0.0390 (-0.22)	2.1525
$\ln DSTK$	-1.8147 (-3.43)	-0.8708 (-1.72)	-0.4352 (-0.59)	0.2545
$\ln POPN$	1.3059 (3.68)	1.0941 (3.63)	3.2364 (6.37)	-4.5795
$R(UC)$	0.0106 (1.66)	0.0215 (2.03)	0.0102 (1.14)	0.1055
$\ln INFL$	0.0104 (0.24)	0.1507 (3.97)	0.0047 (0.07)	-0.0678
$\ln POSS$	0.0152 (0.55)	-0.0041 (-0.14)	0.0304 (0.79)	-0.5249

*t*-statistics in parentheses

**Table A4.3.3 : Estimates of the Long Run Cointegrating Arrears Equation With Constant; Dependent Variable :  $\ln ARR$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
Constant	-3.9454 (-1.25)	-0.8646 (-0.18)	1.1340 (0.22)	-56.8273
$\ln UR$	0.0163 (0.23)	0.1300 (1.17)	0.1255 (1.11)	-1.9020
$\ln R(AIIJ)$	1.3256 (4.28)	0.8749 (1.78)	0.8275 (1.69)	2.6272
$\ln AYR$	1.4023 (3.44)	2.3487 (2.93)	1.9599 (3.06)	3.1538
$\ln UNEW$	-3.0303 (-16.38)	-2.7139 (-9.45)	-3.0019 (-10.10)	4.5119
$\ln DSR$	0.4916 (4.24)	0.3982 (1.99)	0.4390 (2.39)	2.6223

*t*-statistics in parentheses

**Table A4.3.4 : Estimates of the Long Run Cointegrating Arrears Equation Without Constant; Dependent Variable :  $\ln ARR$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
$\ln UR$	0.0496 (0.74)	0.1043 (1.33)	0.1093 (1.05)	-1.1245
$\ln R(AIIJ)$	0.9558 (10.29)	0.8777 (8.58)	0.9135 (6.28)	-1.9969
$\ln AYR$	1.5324 (3.88)	1.8982 (3.34)	1.9321 (3.16)	5.0258
$\ln UNEW$	-3.0828 (-17.06)	-2.9257 (-14.73)	-2.9643 (-10.50)	2.4404
$\ln DSR$	0.5933 (7.15)	0.5255 (5.94)	0.4542 (3.55)	3.2584

*t*-statistics in parentheses



**Table A4.3.5 : Estimates of the Long Run Cointegrating Possessions Equation With Constant; Dependent Variable :  $\ln POSS$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
Constant	-7.2846 (-3.61)	-14.3046 (-2.01)	-16.6411 (-2.24)	-24.4853
$\ln ARR$	1.1290 (7.41)	1.5199 (3.43)	1.1906 (2.17)	1.7992
$R(r_m)$	0.0278 (2.37)	0.0114 (0.22)	0.0238 (0.58)	-0.0452
$\ln UNEW$	1.0522 (1.48)	3.0814 (1.25)	2.7720 (1.08)	4.0559
$\ln R(PAHM)$	-0.0979 (-0.26)	-0.5768 (-0.51)	0.2878 (0.21)	0.8193

*t*-statistics in parentheses

**Table A4.3.6 : Estimates of the Long Run Cointegrating Possessions Equation Without Constant; Dependent Variable :  $\ln POSS$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
$\ln ARR$	0.7144 (6.75)	0.7357 (7.42)	0.4311 (1.08)	-1.1735
$R(r_m)$	0.0234 (1.90)	-0.0189 (-0.49)	-0.0174 (-0.37)	-0.1175
$\ln UNEW$	-1.2702 (-3.98)	-1.5976 (-2.93)	-2.1685 (-1.79)	-7.3232
$\ln R(PAHM)$	0.6428 (1.89)	1.0056 (1.68)	1.6078 (1.24)	7.0528

*t*-statistics in parentheses

- Restricted Sample Period Estimations

**Table A4.3.7 : Estimates of the Long Run Cointegrating Real House Price Equation With Constant; Dependent Variable :  $\ln R(PAHM)$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
Constant	-13.4403 (-16.56)	-14.0372 (-21.64)	-15.6726 (-19.12)	-20.0924
$\ln R(AIIS)$	1.7694 (7.65)	0.9875 (5.12)	1.4334 (6.61)	1.2550
$\ln R(ALDO)$	0.1716 (3.39)	0.1156 (3.79)	0.0428 (0.86)	-0.2332
$\ln DSTK$	-0.8574 (-2.99)	0.2361 (0.89)	-0.1230 (-0.45)	0.7356
$\ln POPN$	1.5794 (11.11)	1.4128 (20.79)	1.9340 (13.71)	2.8846
$R(UC)$	0.0102 (3.99)	-0.0022 (-0.73)	0.0086 (3.55)	0.0079
$\ln INFL$	-0.0066 (-0.31)	0.0202 (1.45)	-0.0470 (-2.31)	-0.1442
$\ln POSS$	-0.1312 (-7.49)	-0.1305 (-10.01)	-0.1831 (-10.81)	-0.2827

*t*-statistics in parentheses

**Table A4.3.8 : Estimates of the Long Run Cointegrating Real House Price Equation Without Constant; Dependent Variable :  $\ln R(PAHM)$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
$\ln R(AIIS)$	3.0327 (6.34)	2.6922 (6.62)	3.4427 (6.59)	3.3468
$\ln R(ALDO)$	0.1583 (1.43)	0.0795 (0.89)	-0.2000 (-1.58)	-0.1551
$\ln DSTK$	-3.6116 (-7.08)	-3.0298 (-6.78)	-3.7948 (-6.81)	-3.6696
$\ln POPN$	1.2633 (4.10)	0.9226 (4.27)	2.3760 (6.78)	1.4755
$R(UC)$	0.0174 (3.15)	0.0099 (1.37)	0.0181 (2.99)	0.0888
$\ln INFL$	-0.0852 (-1.86)	-0.0570 (-1.62)	-0.2018 (-3.91)	-0.4294
$\ln POSS$	0.0742 (2.74)	0.1050 (4.67)	0.0892 (3.02)	-0.3945

*t*-statistics in parentheses



**Table A4.3.9 : Estimates of the Long Run Cointegrating Arrears Equation With Constant; Dependent Variable :  $\ln ARR$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
Constant	15.2396 (4.00)	16.9203 (2.95)	17.9805 (3.39)	-25.6492
$\ln UR$	0.1333 (2.51)	0.1458 (2.20)	0.1423 (1.90)	-0.3320
$\ln R(AIIJ)$	-0.8977 (-2.11)	-1.0924 (-1.68)	-1.2245 (-2.07)	1.3791
$\ln AYR$	1.9407 (6.79)	2.4029 (5.87)	2.4087 (6.00)	3.3032
$\ln UNEW$	-2.2337 (-11.91)	-2.2232 (-10.43)	-2.1655 (-8.02)	1.3418
$\ln DSR$	0.9954 (8.18)	1.0307 (4.63)	1.0870 (6.40)	0.5947

*t*-statistics in parentheses

**Table A4.3.10 : Estimates of the Long Run Cointegrating Arrears Equation Without Constant; Dependent Variable :  $\ln ARR$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
$\ln UR$	0.0147 (0.31)	-0.0298 (-0.33)	-0.0172 (-0.20)	-0.3288
$\ln R(AIIJ)$	0.7719 (8.86)	0.8099 (7.33)	0.9483 (6.00)	-4.7189
$\ln AYR$	1.4237 (5.12)	1.6028 (2.63)	1.6842 (3.47)	6.2437
$\ln UNEW$	-2.5910 (-14.40)	-2.7060 (-12.71)	-2.9959 (-9.21)	8.8911
$\ln DSR$	0.5591 (9.44)	0.5831 (5.48)	0.4791 (4.67)	2.6871

*t*-statistics in parentheses

**Table A4.3.11 : Estimates of the Long Run Cointegrating Possessions Equation With Constant; Dependent Variable :  $\ln POSS$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
Constant	-9.5495 (-3.52)	-18.4579 (-2.99)	-25.5247 (-3.68)	-36.5318
$\ln ARR$	1.6055 (6.84)	2.3061 (5.63)	2.5869 (4.41)	2.1100
$R(r_m)$	0.0134 (0.99)	0.0086 (0.21)	-0.0142 (-0.42)	-0.0334
$\ln UNEW$	2.0450 (2.22)	4.4877 (2.15)	6.1239 (2.63)	7.5835
$\ln R(PAHM)$	-0.5591 (-1.26)	-0.9504 (-1.04)	-1.0017 (-0.90)	-0.1410

*t*-statistics in parentheses

**Table A4.3.12 : Estimates of the Long Run Cointegrating Possessions Equation Without Constant; Dependent Variable :  $\ln POSS$**

	OLS	Park (1992)	Phillips-Hansen (1990)	Phillips (1993)
$\ln ARR$	0.9909 (5.90)	1.0675 (6.58)	0.4789 (0.88)	-4.5683
$R(r_m)$	0.0156 (1.08)	-0.0029 (-0.07)	-0.0100 (-0.22)	0.0422
$\ln UNEW$	-0.9780 (-2.70)	-1.4872 (-2.57)	-2.7311 (-2.33)	-10.8104
$\ln R(PAHM)$	0.3763 (0.99)	0.9982 (1.53)	2.2811 (1.85)	10.2311

*t*-statistics in parentheses



## APPENDIX TO CHAPTER 5

### APPENDIX 5.1 : DERIVATION OF THE LAGRANGE MULTIPLIER

Given that the Lagrange multiplier ( $\gamma$ ) is zero when  $\lambda = 0$ ,  $\gamma$  is derived here for Cases 2 and 3 alone.

- *Case 2 :  $\lambda = 1$ , Complete Member Orientation*

For  $\lambda = 1$ , the optimal rates are given in equations (5.59) and (5.60) in the main text, i.e.

$$r_L^* = \frac{X}{2(1+\gamma)} + \frac{p}{2\alpha} \quad (\text{A5.1})$$

and

$$r_S^* = \frac{Y}{2(1+\gamma)} + \frac{q}{2\beta} \quad (\text{A5.2})$$

where  $X = 2r_{LM} + \gamma(r_{LM} + r_{DM} + C_L)$  and  $Y = 2r_{SM} + \gamma(r_{SM} + r_{DM} - C_S)$ . Substituting these optimal rates into the budget constraint of equation (5.17), cancelling terms and rearranging gives

$$\begin{aligned} \frac{p^2}{4\alpha} + \frac{q^2}{4\beta} + \frac{p(r_{LM} - r_{DM} - C_L)}{2} + \frac{q(r_{DM} - r_{SM} - C_S)}{2} - \alpha r_{LM} r_{DM} \\ - \beta r_{SM} r_{DM} - \alpha r_{LM} C_L + \beta C_S r_{SM} - \bar{E} \geq \frac{\alpha X^2}{[2(1+\gamma)]^2} + \frac{\beta Y^2}{[2(1+\gamma)]^2} \end{aligned} \quad (\text{A5.3})$$

$$-\frac{\alpha r_{DM} X}{2(1+\gamma)} - \frac{\beta r_{DM} Y}{2(1+\gamma)} - \frac{\alpha C_L X}{2(1+\gamma)} + \frac{\beta C_S Y}{2(1+\gamma)} - \frac{\alpha r_{LM} X}{2(1+\gamma)} - \frac{\beta r_{SM} Y}{2(1+\gamma)}$$

Multiplying both sides by  $[2(1+\gamma)]^2$ , expanding  $Y$  and  $X$ , collecting terms and rearranging gives

$$\begin{aligned}
 & p^2(1+\gamma)^2 / \alpha + q^2(1+\gamma)^2 / \beta + 2p(r_{LM} - r_{DM} - C_L)(1+\gamma)^2 \\
 & + 2q(r_{DM} - r_{SM} - C_S)(1+\gamma)^2 - [2(1+\gamma)]^2 \bar{E} \\
 & + 2(1+\gamma)\{\alpha r_{DM}^2 + 2\alpha r_{DM}C_L + \alpha C_L^2 + 2\alpha r_{LM}^2 + \alpha r_{LM}^2 \\
 & - 2\beta r_{SM}C_S + \beta C_S^2 + \beta r_{DM}^2 + 2\beta r_{SM}^2 + \beta r_{SM}^2\} \geq \alpha Z^2 + \beta Y^2
 \end{aligned} \tag{A5.4}$$

Expanding terms in  $Y^2$  and  $X^2$  and rearranging gives

$$\begin{aligned}
 & p^2(1+\gamma)^2 / \alpha + q^2(1+\gamma)^2 / \beta + 2p(r_{LM} - r_{DM} - C_L)(1+\gamma)^2 \\
 & + 2q(r_{DM} - r_{SM} - C_S)(1+\gamma)^2 - [2(1+\gamma)]^2 \bar{E} \geq \\
 & -(\gamma^2 + 2\gamma)\{\alpha r_{LM}^2 + \alpha r_{DM}^2 + \alpha C_L^2 + 2\alpha r_{DM}C_L - 2\alpha r_{LM}C_L - 2\alpha r_{LM}r_{DM} \\
 & + \beta r_{SM}^2 + \beta r_{DM}^2 + \beta C_S^2 - 2\beta C_S r_{DM} - 2\beta r_{SM}r_{DM} + 2\beta r_{SM}C_S\}
 \end{aligned} \tag{A5.5}$$

Factorising the term in braces and rearranging yields

$$\begin{aligned}
 & \frac{(\gamma^2 + 2\gamma)}{(1+\gamma)^2} [\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2] \geq \\
 & 4\bar{E} - [p^2 / \alpha + q^2 / \beta + 2p(r_{LM} - r_{DM} - C_L) + 2q(r_{DM} - r_{SM} - C_S)]
 \end{aligned} \tag{A5.6}$$

Finally, given that the budget constraint holds as an equality we may solve (A5.6) as a quadratic equation, giving an expression for  $\gamma$  as

$$\gamma = \frac{1}{\left[1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]}\right]^{1/2}} - 1 \tag{A5.7}$$

as shown in equation (5.63) in the main text, where

$$Z = 4\bar{E} - \left[ \frac{p^2}{\alpha} + \frac{q^2}{\beta} + 2p(r_{LM} - r_{DM} - C_L) + 2q(r_{DM} - r_{SM} - C_S) \right] \tag{A5.8}$$



• *Case 3 :  $\lambda = 0.5$ , Equal Weighting on Member Benefits and Profit*

For  $\lambda = 0.5$ , the optimal rates are

$$r_L^* = \frac{r_{LM} + r_{DM} + C_L}{2} - \frac{r_{DM} - r_{LM} + C_L}{4\gamma} + \frac{p}{2\alpha} \quad (\text{A5.9})$$

and

$$r_S^* = \frac{r_{SM} + r_{DM} - C_S}{2} + \frac{r_{SM} - r_{DM} + C_S}{4\gamma} - \frac{q}{2\beta} \quad (\text{A5.10})$$

Substituting these optimal loan and savings rate equations into the budget constraint of equation (5.17), cancelling terms and rearranging gives<sup>1</sup>

$$\left(1 - \frac{1}{4\gamma^2}\right) [\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2] \geq 4\bar{E} - [p^2 / \alpha + q^2 / \beta + 2p(r_{LM} - r_{DM} - C_L) + 2q(r_{DM} - r_{SM} - C_S)] \quad (\text{A5.11})$$

Finally, given that the budget constraint holds as an equality we solve equation (A5.11) as a quadratic, giving an expression for  $\gamma$  as

$$\gamma = \frac{1}{\left[4 - \frac{4Z}{\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2}\right]^{1/2}} \quad (\text{A5.12})$$

as shown in equation (5.67) in the text, where  $Z$  is as defined previously.

<sup>1</sup> The algebra involved in this process is long and tedious, arising from the necessity to expand squared terms in the optimal rates of equations (A5.9) and (A5.10) and thus is not reported here.

## APPENDIX 5.2 : THE SIGN OF THE HESSIAN MATRIX OF SECOND DERIVATIVES OF THE OBJECTIVE AND CONSTRAINT FUNCTIONS

### A5.2.1 The Complete Objective Function

From equation (5.20) in the main text, the objective function ( $Q$ ) is written

$$\begin{aligned} Q = & \lambda(r_{LM} - r_L)f(r_L) + \lambda(r_S - r_{SM})g(r_S) + (1-\lambda)r_Lf(r_L) \\ & - (1-\lambda)r_Sg(r_S) - (1-\lambda)r_{DM}\{f(r_L) - g(r_S)\} \\ & - (1-\lambda)C_Lf(r_L) - (1-\lambda)C_Sg(r_S) - (1-\lambda)\bar{E} \end{aligned} \quad (A5.13)$$

with first and second derivatives with respect to  $r_L$

$$\begin{aligned} Q_{r_L} = & -\lambda f(r_L) + \lambda(r_{LM} - r_L)f'(r_L) + (1-\lambda)f(r_L) \\ & + (1-\lambda)r_Lf'(r_L) - (1-\lambda)r_{DM}f'(r_L) - (1-\lambda)C_Lf'(r_L) \end{aligned} \quad (A5.14)$$

and

$$\begin{aligned} Q_{r_L r_L} = & -\lambda f'(r_L) - \lambda f'(r_L) + \lambda(r_{LM} - r_L)f''(r_L) \\ & + (1-\lambda)f'(r_L) + (1-\lambda)f'(r_L) + (1-\lambda)r_Lf''(r_L) \\ & - (1-\lambda)r_{DM}f''(r_L) - (1-\lambda)C_Lf''(r_L) \end{aligned} \quad (A5.15)$$

or

$$\begin{aligned} Q_{r_L r_L} = & f'(r_L)[2(1-\lambda) - 2\lambda] \\ & + f''(r_L)[\lambda(r_{LM} - r_L) + (1-\lambda)r_L - (1-\lambda)r_{DM} - (1-\lambda)C_L] \end{aligned} \quad (A5.16)$$

which reduces to

$$Q_{r_L r_L} = f'(r_L)[2(1-\lambda) - 2\lambda] \quad (A5.17)$$

on the assumption that  $f''(r_L) = 0$ .



The objective function has first and second derivatives with respect to  $r_S$  as follows

$$Q_{r_S} = \lambda(r_S - r_{SM})g'(r_S) + \lambda g(r_S) - (1 - \lambda)r_S g'(r_S) - (1 - \lambda)g(r_S) \\ + (1 - \lambda)r_{DM}g'(r_S) - (1 - \lambda)C_S g'(r_S) \quad (\text{A5.18})$$

and

$$Q_{r_S r_S} = \lambda(r_S - r_{SM})g''(r_S) + \lambda g'(r_S) + \lambda g'(r_S) \\ - (1 - \lambda)r_S g''(r_S) - (1 - \lambda)g'(r_S) - (1 - \lambda)g'(r_S) \\ + (1 - \lambda)r_{DM}g''(r_S) - (1 - \lambda)C_S g''(r_S) \quad (\text{A5.19})$$

or

$$Q_{r_S r_S} = g'(r_S)[2\lambda - 2(1 - \lambda)] \\ + g''(r_S)[\lambda(r_S - r_{SM}) - (1 - \lambda)r_S + (1 - \lambda)r_{DM} - (1 - \lambda)C_S] \quad (\text{A5.20})$$

which reduces to

$$Q_{r_S r_S} = g'(r_S)[2\lambda - 2(1 - \lambda)] \quad (\text{A5.21})$$

on the assumption that  $g''(r_S) = 0$ . The Hessian matrix for the objective function may then be written using equations (A5.17) and (A5.21) as equation (5.70) in the main text shows.

### A5.2.2 NGL and NGS Functions

From equation (5.12) in the main text, we have

$$NGL = (r_{LM} - r_L)L = (r_{LM} - r_L)f(r_L) \quad (\text{A5.22})$$

with first and second derivatives with respect to  $r_L$  of

$$NGL_{r_L} = (r_{LM} - r_L)f'(r_L) - f(r_L) \quad (\text{A5.23})$$

and

$$NGL_{r_L r_L} = (r_{LM} - r_L)f''(r_L) - 2f'(r_L) \quad (\text{A5.24})$$

which reduces to

$$NGL_{r_L r_L} = -2f'(r_L) > 0 \quad (\text{A5.25})$$

on the assumption that  $f''(r_L) = 0$ .

Similarly, from equation (5.13) in the text, we have

$$NGS = (r_S - r_{SM})S = (r_S - r_{SM})g(r_S) \quad (\text{A5.26})$$

with first and second derivatives with respect to  $r_S$

$$NGS_{r_S} = (r_S - r_{SM})g'(r_S) + g(r_S) \quad (\text{A5.27})$$

and

$$NGS_{r_S r_S} = (r_S - r_{SM})g''(r_S) + 2g'(r_S) \quad (\text{A5.28})$$

which reduces to

$$NGS_{r_S r_S} = 2g'(r_S) > 0 \quad (\text{A5.29})$$

on the assumption that  $g''(r_S) = 0$ .

The Hessian matrix for the member benefits part of the objective function in equation (5.16) may then be written

$$H = \begin{bmatrix} -2f'(r_L) & 0 \\ 0 & 2g'(r_S) \end{bmatrix} \quad (\text{A5.30})$$

The Hessian matrix is positive definite irrespective of the value of  $\lambda$  thus indicating convexity of underlying objective function.



### A5.2.3 The Constraint Function

From equation (5.21) in the main text, the constraint function is

$$\begin{aligned} \pi = & r_L f(r_L) - r_S g(r_S) - r_{DM} \{f(r_L) - g(r_S)\} \\ & - C_L f(r_L) - C_S g(r_S) - \bar{E} \geq 0 \end{aligned} \quad (\text{A5.31})$$

with first and second derivatives with respect to  $r_L$  of

$$\pi_{r_L} = f(r_L) + r_L f'(r_L) - r_{DM} f'(r_L) - C_L f'(r_L) \quad (\text{A5.32})$$

and

$$\begin{aligned} \pi_{r_L r_L} &= f'(r_L) + f'(r_L) + r_L f''(r_L) - r_{DM} f''(r_L) - C_L f''(r_L) \\ &= 2f'(r_L) + f''(r_L)[r_L - r_{DM} - C_L] \end{aligned} \quad (\text{A5.33})$$

which reduces to

$$\pi_{r_L r_L} = 2f'(r_L) \quad (\text{A5.34})$$

on the assumption that  $f''(r_L) = 0$ .

The constraint function has first and second derivatives with respect to  $r_S$  as follows

$$\pi_{r_S} = -r_S g'(r_S) - g(r_S) + r_{DM} g'(r_S) - C_S g'(r_S) \quad (\text{A5.35})$$

and

$$\begin{aligned} \pi_{r_S r_S} &= -r_S g''(r_S) - g'(r_S) - g'(r_S) + r_{DM} g''(r_S) - C_S g''(r_S) \\ &= -2g'(r_S) + g''(r_S)[r_{DM} - r_S - C_S] \end{aligned} \quad (\text{A5.36})$$

which reduces to

$$\pi_{r_S r_S} = -2g'(r_S) \quad (\text{A5.37})$$

on the assumption that  $g'(r_s) = 0$ . The Hessian matrix for the constraint function may then be written using equations (A5.34) and (A5.37) as equation (5.69) in the main text shows. The Hessian matrix is negative definite irrespective of  $\lambda$  thus indicating the concavity of the underlying constraint function.

#### A5.2.4 The Bordered Hessian Matrix for the Optimisation Problem

The bordered Hessian matrix may be written as

$$\bar{H} = \begin{bmatrix} 0 & \frac{\partial \pi}{\partial r_L} & \frac{\partial \pi}{\partial r_S} \\ \frac{\partial \pi}{\partial r_L} & \frac{\partial^2 \ell}{\partial r_L^2} & \frac{\partial^2 \ell}{\partial r_L \partial r_S} \\ \frac{\partial \pi}{\partial r_S} & \frac{\partial^2 \ell}{\partial r_S \partial r_L} & \frac{\partial^2 \ell}{\partial r_S^2} \end{bmatrix} \quad (\text{A5.38})$$

We require that the determinant of (A5.38) is greater than 0. Given the assumption of

$\frac{\partial^2 \ell}{\partial r_L \partial r_S} = \frac{\partial^2 \ell}{\partial r_S \partial r_L} = 0$ , the determinant can be calculated as

$$|\bar{H}| = - \left[ \left( \frac{\partial \pi}{\partial r_S} \right)^2 \frac{\partial^2 \ell}{\partial r_L^2} + \left( \frac{\partial \pi}{\partial r_L} \right)^2 \frac{\partial^2 \ell}{\partial r_S^2} \right] > 0 \quad (\text{A5.39})$$

To evaluate  $|\bar{H}|$  we find expressions for the second partial derivatives of the Lagrangian function with respect to  $r_L$  and  $r_S$ .

$$\begin{aligned} \ell_{r_L} &= \lambda(r_{LM} - r_L)f'(r_L) - \lambda f(r_L) + (1-\lambda)r_L f'(r_L) \\ &\quad + (1-\lambda)f(r_L) - (1-\lambda)r_{DM}f'(r_L) - (1-\lambda)C_L f'(r_L) \\ &\quad - \gamma r_L f'(r_L) - \gamma f(r_L) + \gamma r_{DM}f'(r_L) + \gamma C_L f'(r_L) \end{aligned} \quad (\text{A5.40})$$



and

$$\begin{aligned}\ell_{r_L r_L} = & \lambda(r_{LM} - r_L)f''(r_L) - \lambda f'(r_L) - \lambda f'(r_L) + (1 - \lambda)r_L f''(r_L) \\ & + (1 - \lambda)f'(r_L) + (1 - \lambda)f'(r_L) - (1 - \lambda)r_{DM}f''(r_L) \\ & - (1 - \lambda)C_L f''(r_L) - \gamma r_L f''(r_L) - \gamma f'(r_L) - \gamma f'(r_L) \\ & + \gamma r_{DM}f''(r_L) + \gamma C_L f''(r_L)\end{aligned}\quad (\text{A5.41})$$

or

$$\begin{aligned}\ell_{r_L r_L} = & 2f'(r_L)[1 - 2\lambda - \gamma] + f''(r_L)[\lambda(r_{LM} - r_L) + (1 - \lambda)r_L \\ & - (1 - \lambda)r_{DM} - (1 - \lambda)C_L - \gamma(r_L - r_{DM} - C_L)]\end{aligned}\quad (\text{A5.42})$$

which reduces to

$$\ell_{r_L r_L} = 2f'(r_L)[1 - 2\lambda - \gamma]\quad (\text{A5.43})$$

on the assumption that  $f''(r_L) = 0$ .

$$\begin{aligned}\ell_{r_S} = & \lambda(r_S - r_{SM})g'(r_S) + \lambda g(r_S) - (1 - \lambda)r_S g'(r_S) \\ & - (1 - \lambda)g(r_S) + (1 - \lambda)r_{DM}g'(r_S) - (1 - \lambda)C_S g'(r_S) \\ & + \gamma r_S g'(r_S) + \gamma g(r_S) - \gamma r_{DM}g'(r_S) + \gamma C_S g'(r_S)\end{aligned}\quad (\text{A5.44})$$

and

$$\begin{aligned}\ell_{r_S r_S} = & \lambda(r_S - r_{SM})g''(r_S) + \lambda g'(r_S) + \lambda g'(r_S) - (1 - \lambda)r_S g''(r_S) \\ & - (1 - \lambda)g'(r_S) - (1 - \lambda)g'(r_S) + (1 - \lambda)r_{DM}g''(r_S) - (1 - \lambda)C_S g''(r_S) \\ & + \gamma r_S g''(r_S) + \gamma g'(r_S) + \gamma g'(r_S) - \gamma r_{DM}g''(r_S) + \gamma C_S g''(r_S)\end{aligned}\quad (\text{A5.45})$$

or

$$\begin{aligned}\ell_{r_S r_S} = & 2g'(r_S)[2\lambda - 1 + \gamma] + g''(r_S)[\lambda(r_S - r_{SM}) - (1 - \lambda)r_S \\ & + (1 - \lambda)r_{DM} - (1 - \lambda)C_S + \gamma(r_S - r_{DM} + C_S)]\end{aligned}\quad (\text{A5.46})$$

which reduces to

$$\ell_{r_S r_S} = -2g'(r_S)[1 - 2\lambda - \gamma]\quad (\text{A5.47})$$

on the assumption that  $g''(r_S) = 0$ .

The determinant of the bordered Hessian matrix may then be written

$$|\bar{H}| = - \left[ \left( \frac{\partial \pi}{\partial r_s} \right)^2 2(1-2\lambda+\gamma)f'(r_L) - \left( \frac{\partial \pi}{\partial r_L} \right)^2 2(1-2\lambda+\gamma)g'(r_s) \right] > 0 \quad (\text{A5.48})$$

For this expression to be unequivocally positive, we require the first term in the square brackets to be negative and the second term positive. Since  $f'(r_L)$  is assumed negative and  $g'(r_s)$  positive from equations (5.43) and (5.44) in the main text, the condition for the positivity of the determinant in (A5.48) becomes

$$(1-2\lambda+\gamma) > 0 \quad (\text{A5.49})$$

or

$$\gamma > 2\lambda - 1 \quad (\text{A5.50})$$

Substituting in for  $\gamma$  as given in equation (5.47) in the main text, the condition becomes

$$\frac{\lambda}{\left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2}} > 2(2\lambda - 1) \quad (\text{A5.51})$$

or

$$\lambda < \frac{2}{4 - \frac{1}{\left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2}}} \quad (\text{A5.52})$$

For  $\lambda = 1$ , this would mean that the condition

$$\left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2} < 1/2 \quad (\text{A5.53})$$

would ensure a maximum of the objective function  $Q$  subject to the profit constraint.



For  $\lambda = 0.5$ , to ensure the existence of a maximum of  $Q$  subject to the non-negative profit constraint we thus require that

$$\left[ 1 - \frac{Z}{[\alpha(r_{LM} - r_{DM} - C_L)^2 + \beta(r_{DM} - r_{SM} - C_S)^2]} \right]^{1/2} > 0 \quad (\text{A5.54})$$

which must be the case if we take the positive root of the term in square brackets.

Clearly, when  $\lambda = 0$  we have  $\gamma = 0$  and condition (A5.50) will always be satisfied.

APPENDIX TO CHAPTER 6

APPENDIX 6.1 : FIGURES OF THE COINTEGRATED SERIES

Figure A6.1.1 : Total Real Net Advances Secured on Dwellings,  $R(AAPR)$  (£m, Constant 1990 Prices)

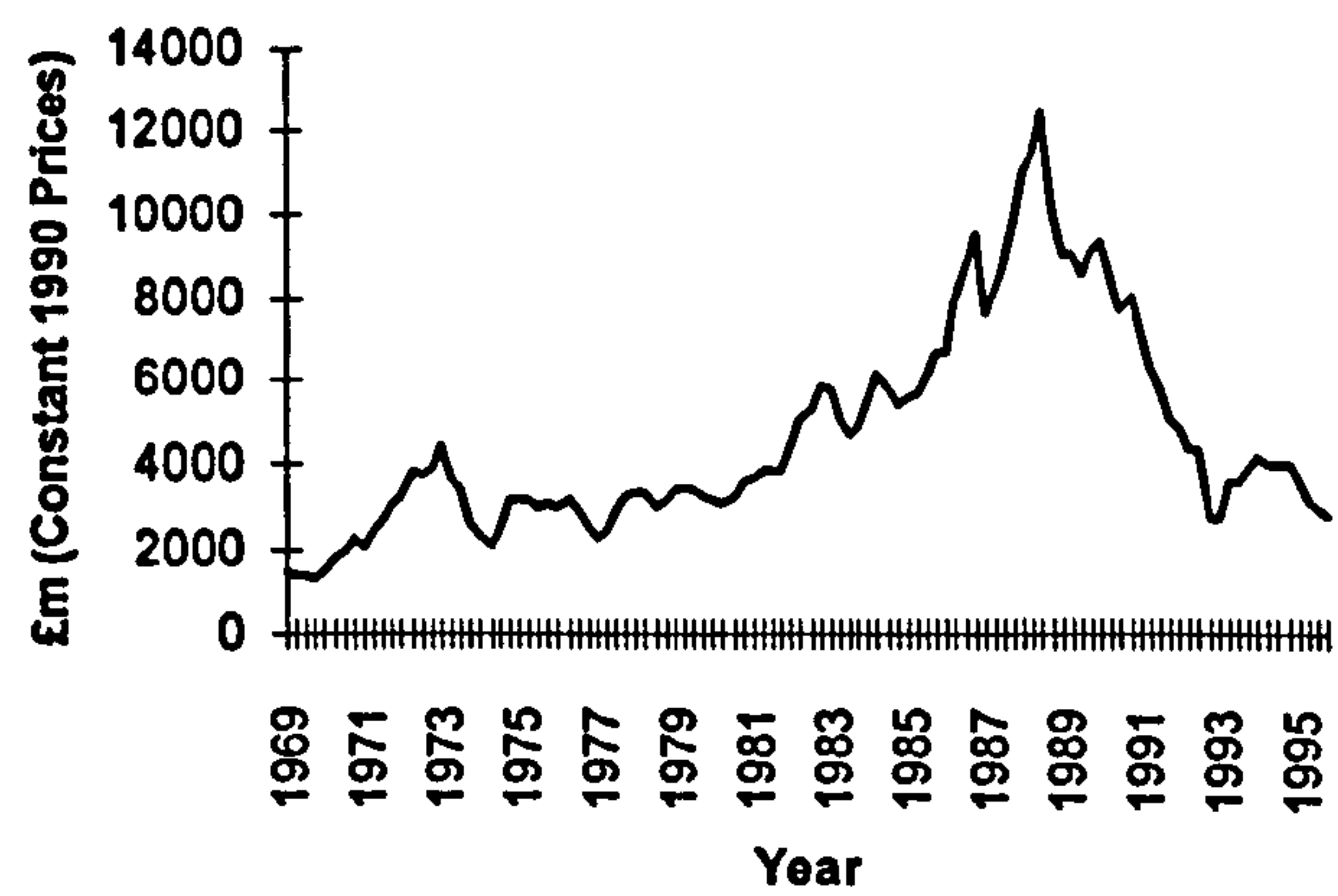


Figure A6.1.2 : The Inflation Rate,  $INFL$ , and the Real After-Tax Mortgage Interest Rate,  $R(r_m)$  (percentage)

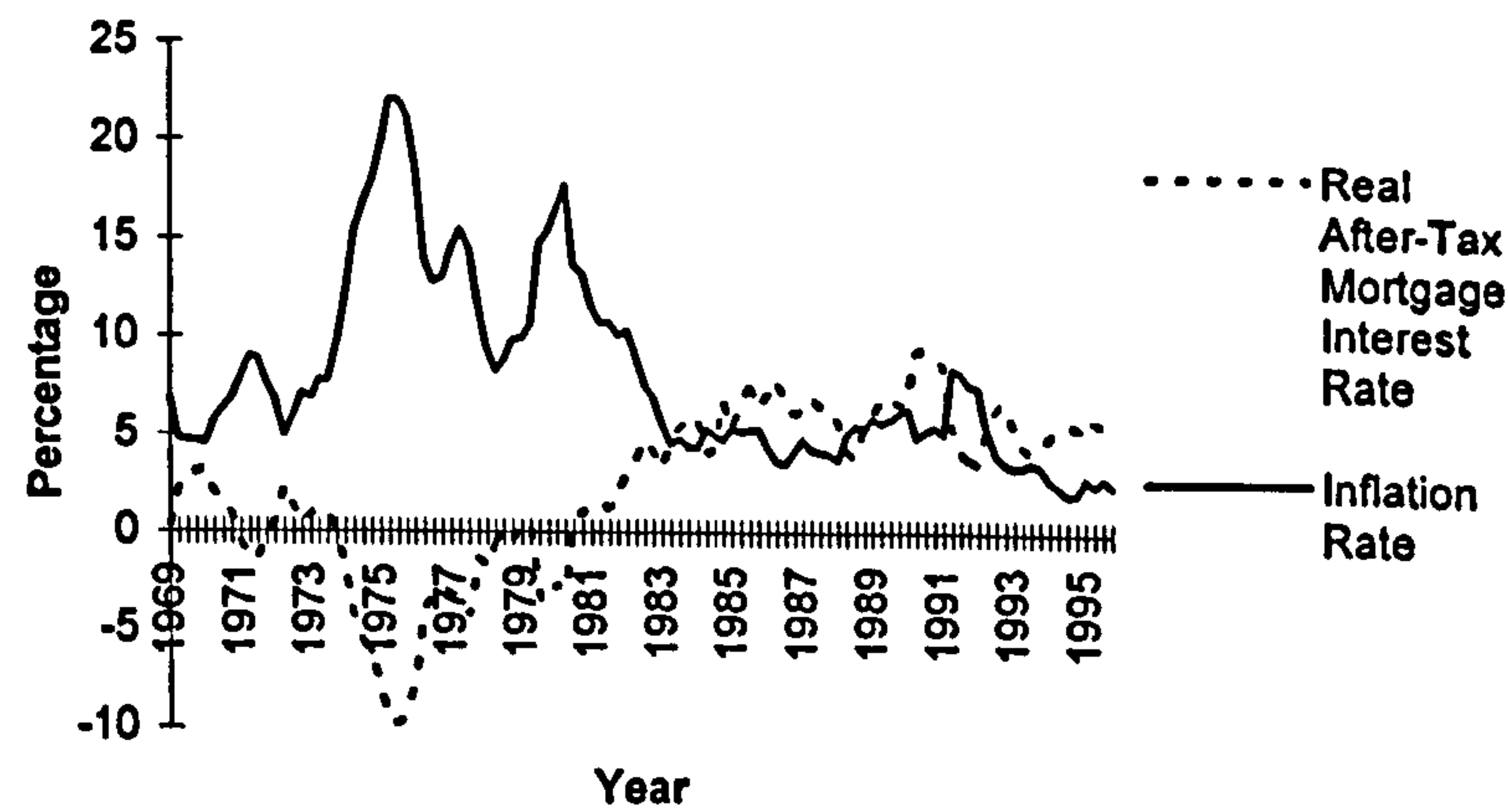




Figure A6.1.3 : The Loan to Value Ratio for Building Societies' First Time Buyers, *ZLVF* (percentage)

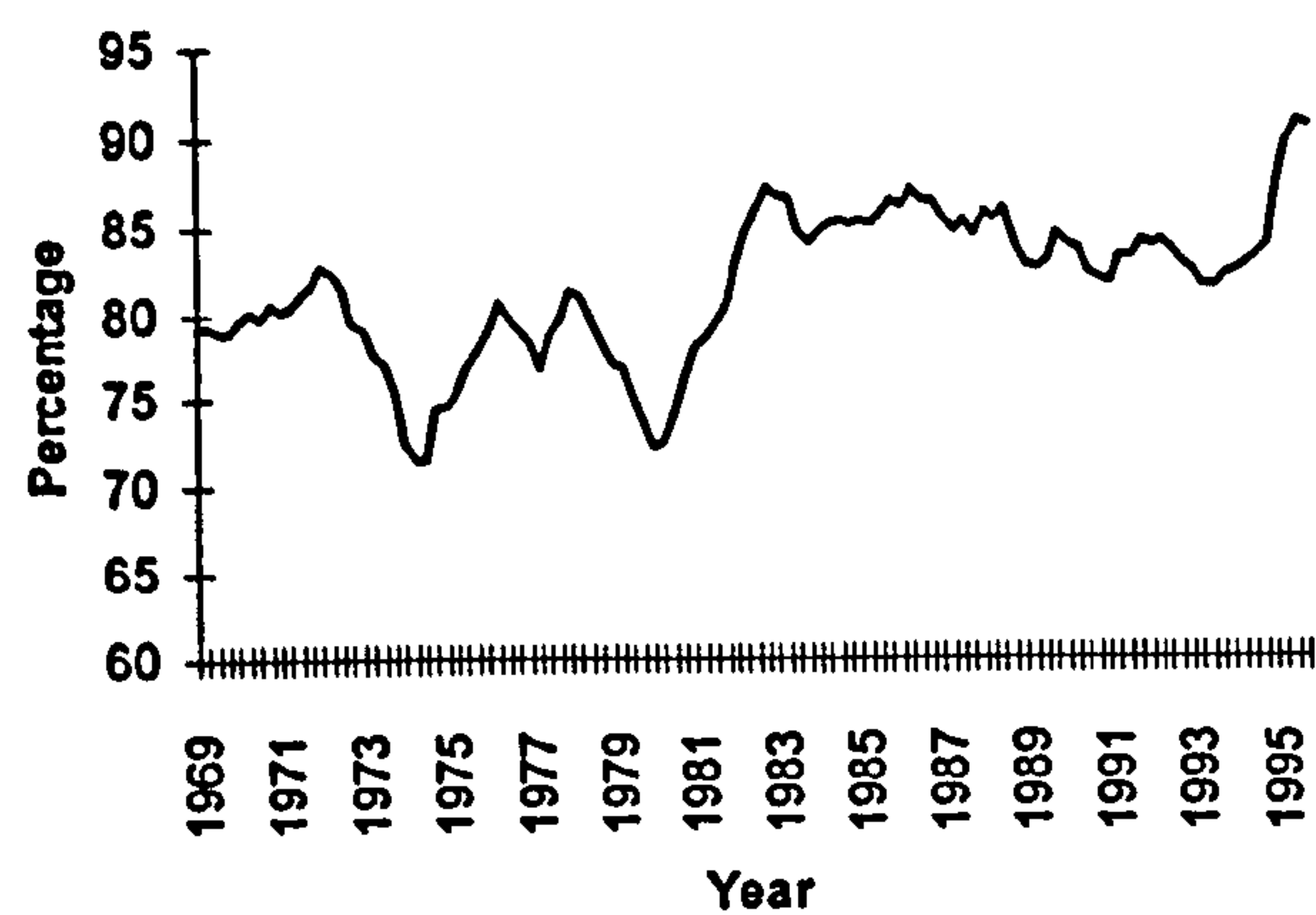


Figure A6.1.4 : Value of Personal Sector Dwelling Stock per Pound of Outstanding Mortgage Debt, *COLLAT* (percentage)

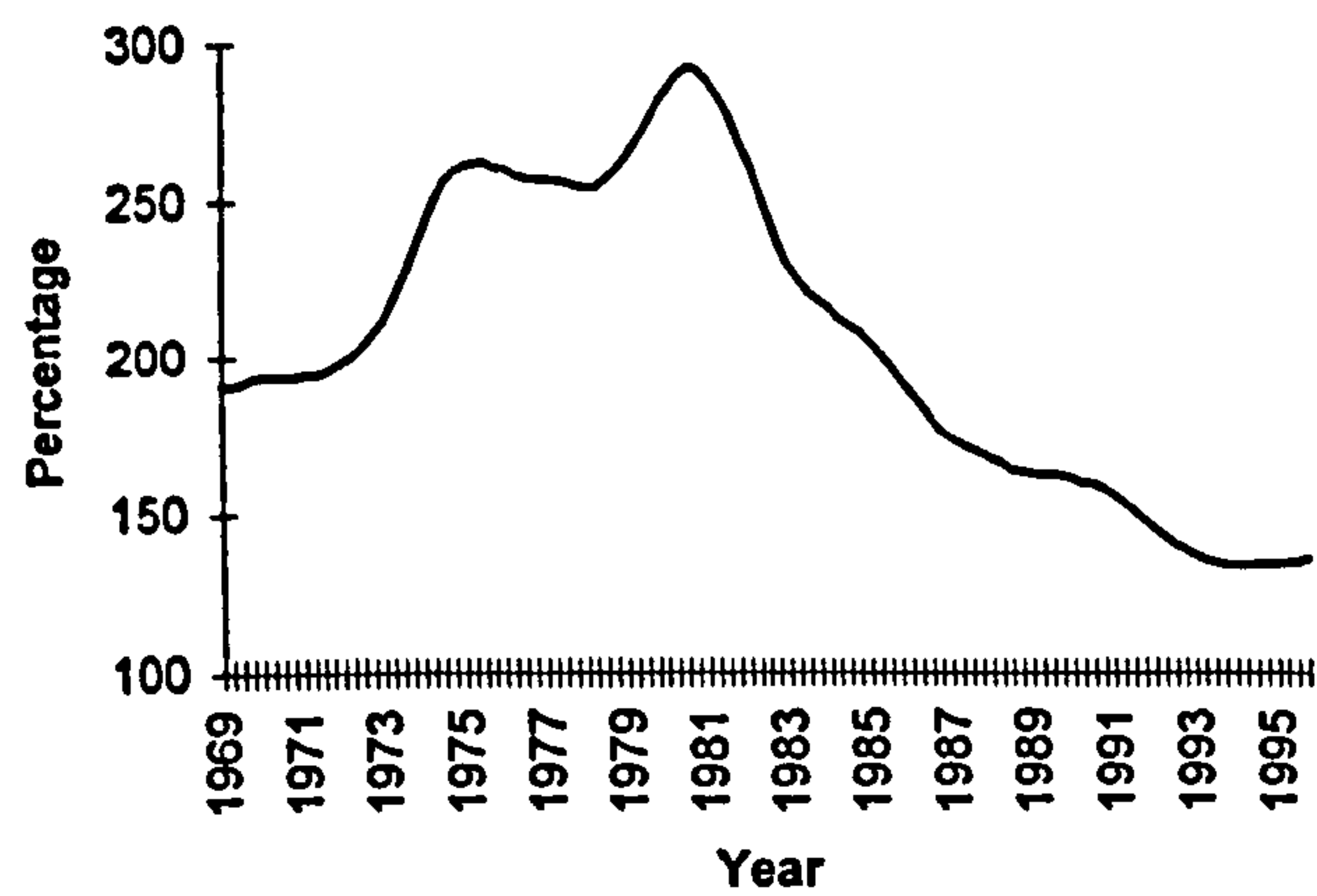


Figure A6.1.5 : Real Personal Sector Saving per Period, *R(AAAU)* (£m, Constant 1990 Prices)

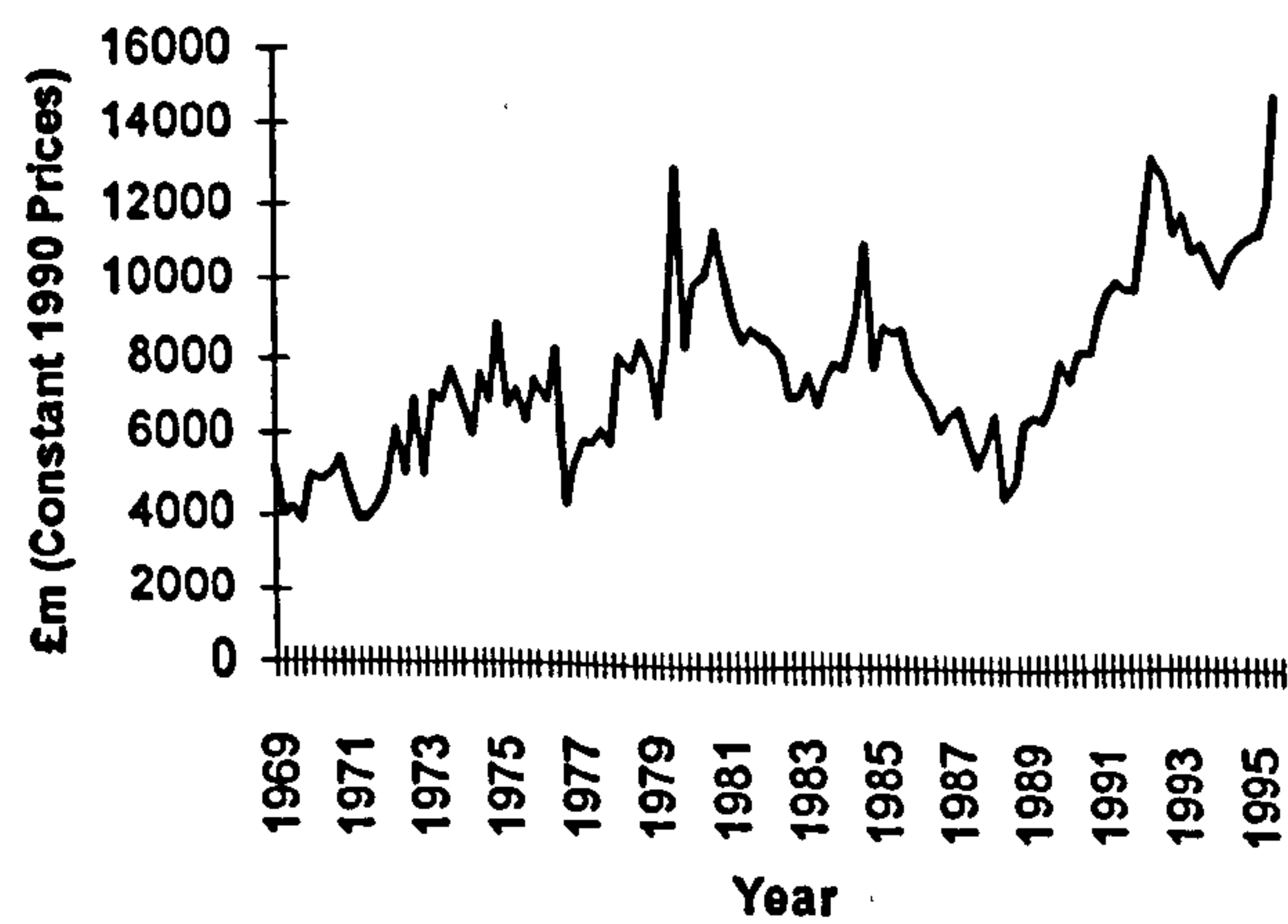


Figure A6.1.6 : Real Mix Adjusted House Price Index,  $R(PAHM)$  (Index, 1990=100)

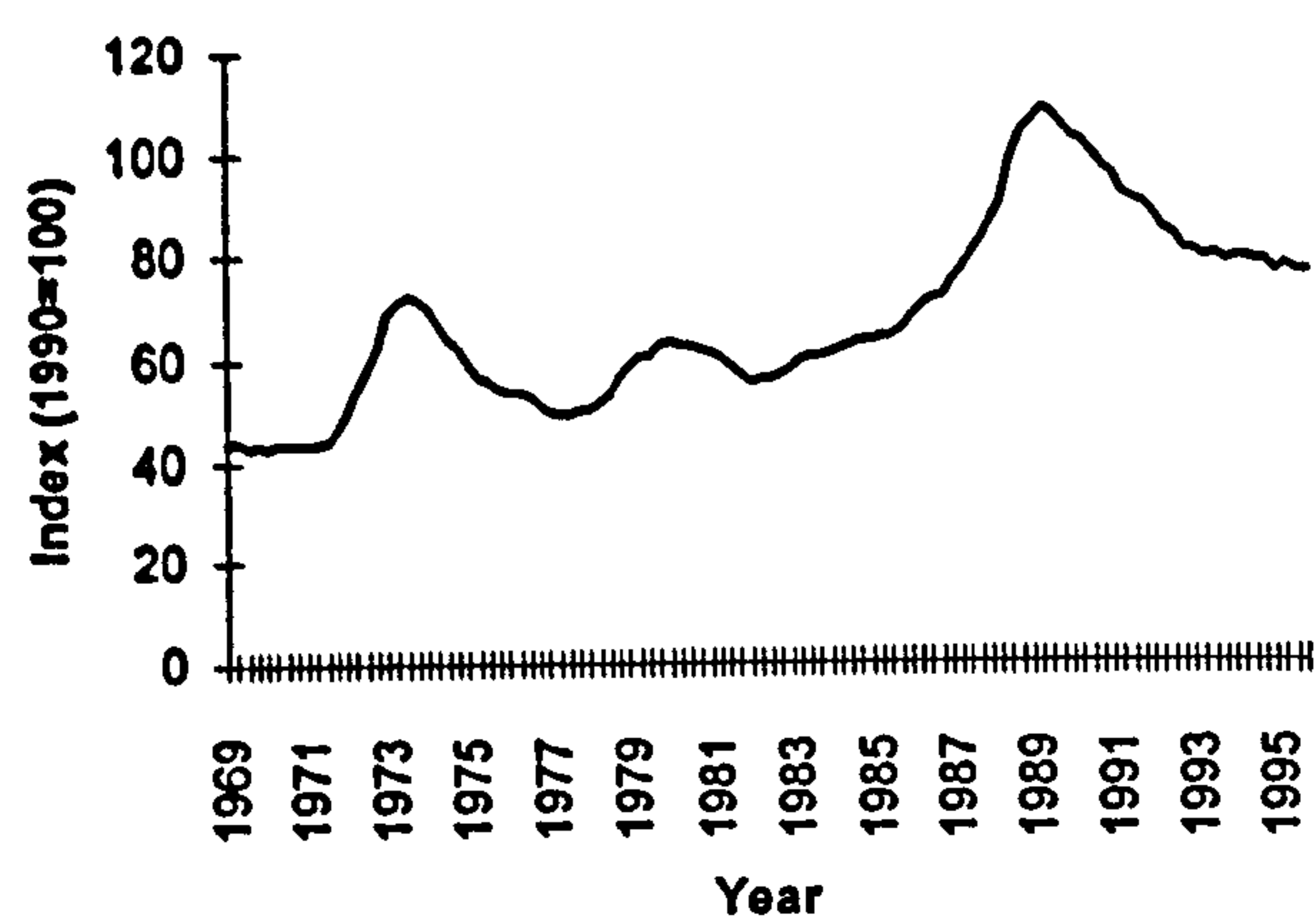


Figure A6.1.7 : Total Level of Real Financial Assets,  $R(ALDO)$  (£bn, Constant 1990 Prices)

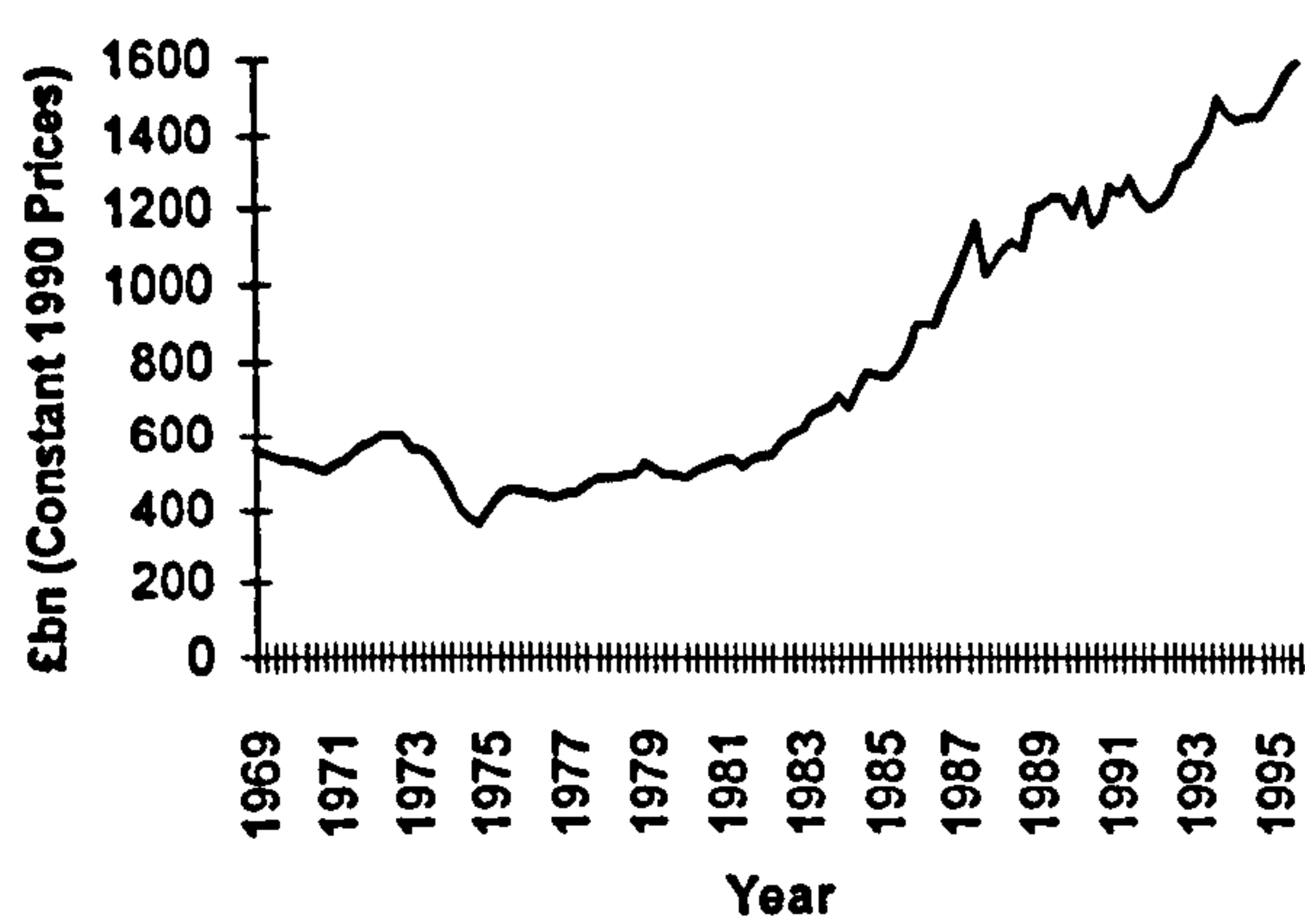
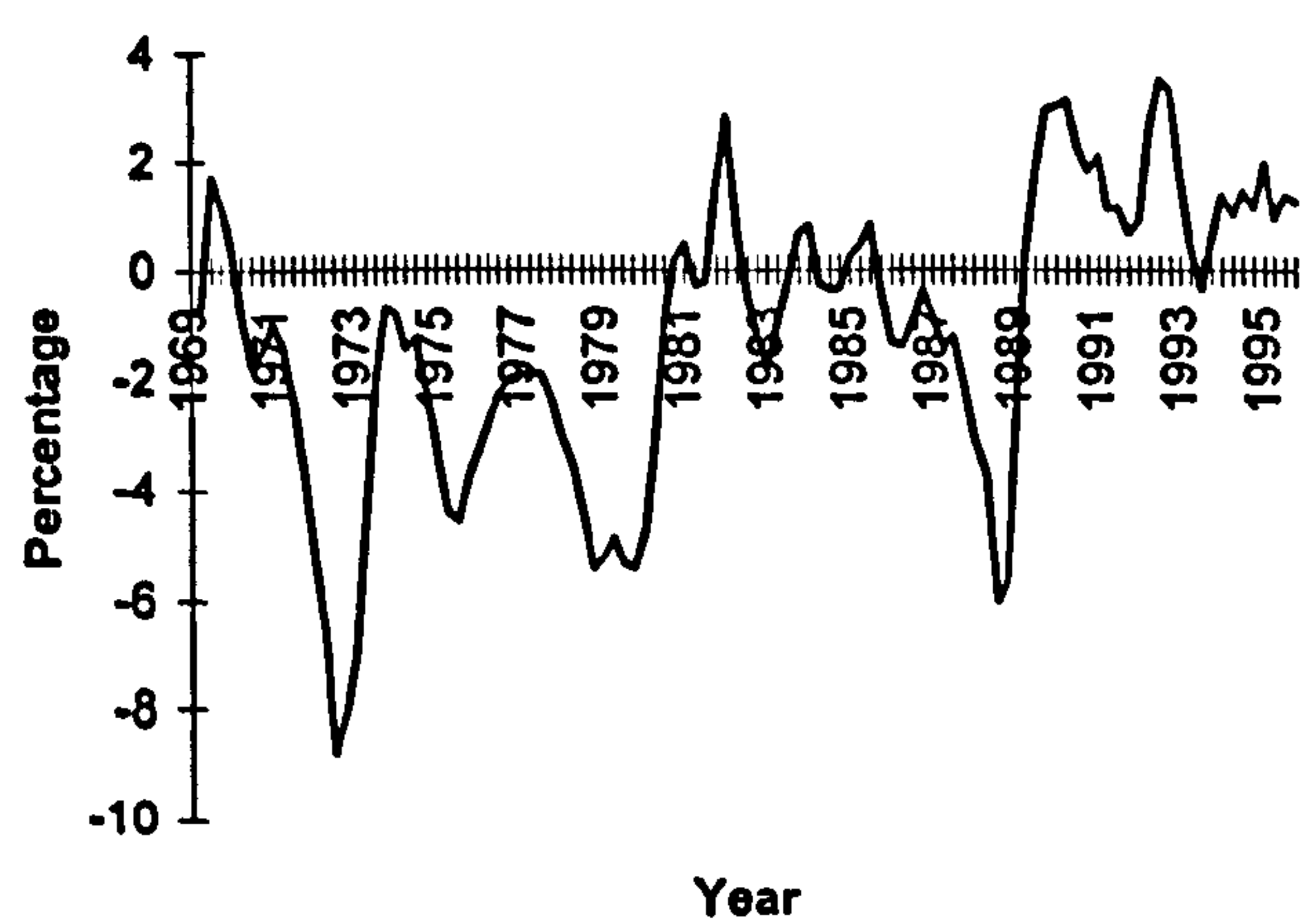
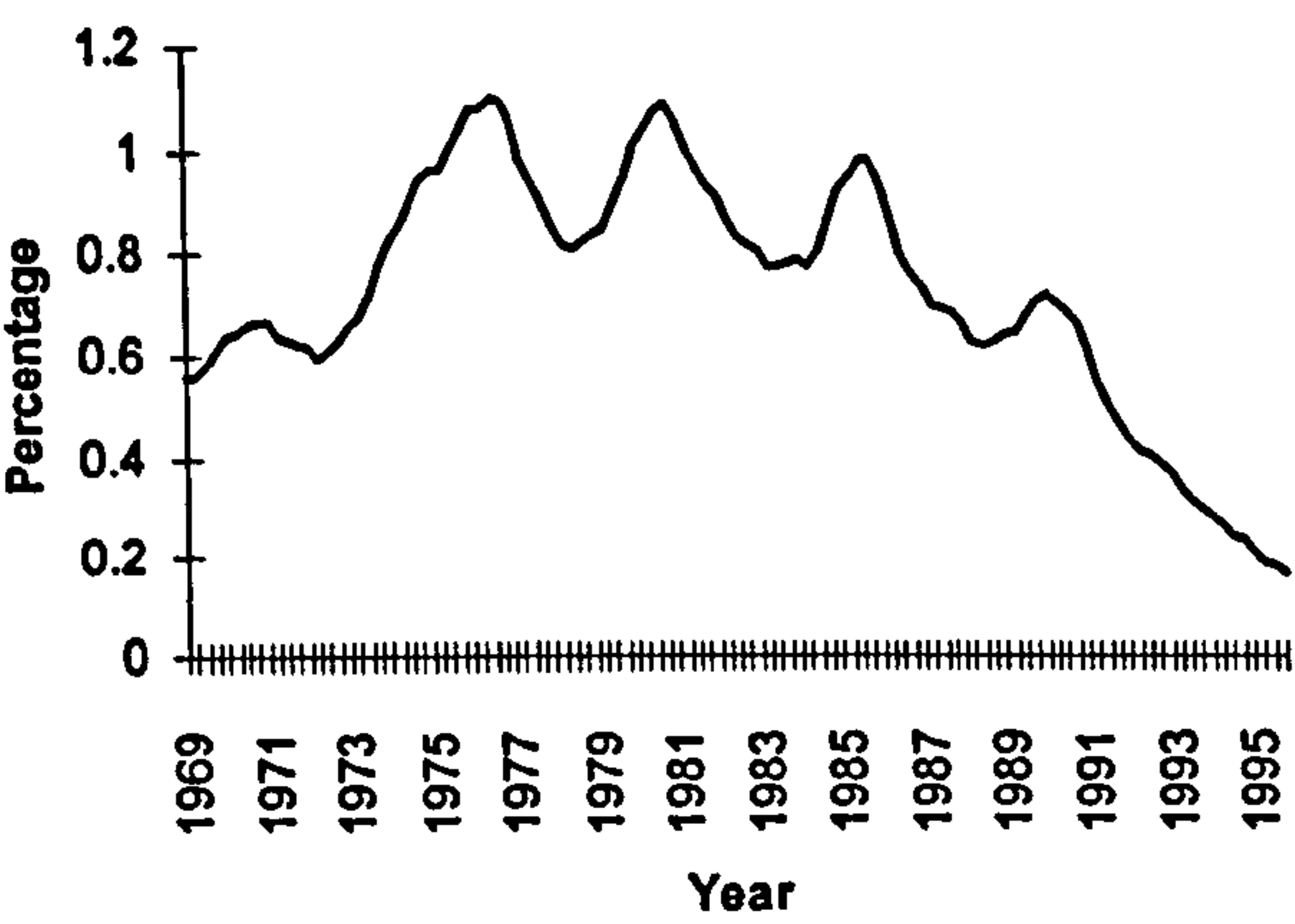


Figure A6.1.8 : Real User Cost of Housing Capital,  $R(UC)$  (percentage)





**Figure A6.1.9 : Cost of Mortgage Interest Relief at Source per Pound of Outstanding Mortgage Debt, *MIRAS* (percentage)**



## APPENDIX 6.2 : THE X11 PROCEDURE FOR SEASONAL ADJUSTMENT

The following discussion of the X11 procedure is adapted from the manual of the statistical package SAS.

The X11 procedure in SAS performs three iterations providing estimates of seasonal ( $S$ ), trading day ( $TD$ ), trend cycle ( $C$ ) and irregular ( $I$ ) components of equation (6.6) in the main text, with each iteration generating more refined estimates.

*Iteration 1 :* A centred 4 period moving average is applied to the original series ( $O$ ) to provide an initial estimate of the trend cycle series. The original series is then divided by this trend cycle component to yield an estimate of the seasonal and irregular components (denoted the  $S$ - $I$  ratio).

A moving average is then applied to the  $S$ - $I$  ratio to obtain the seasonal factors, which are divided into the  $S$ - $I$  ratio series to obtain the irregular component. A moving standard deviation of the irregular component is used to assign weights to the quarterly irregular values to measure each observation's degree of extremity, the weights then being used to modify the extreme values of the  $S$ - $I$  ratio series. New seasonal factors are estimated by taking the moving average of this adjusted  $S$ - $I$  ratio component. A preliminary seasonally adjusted series is then constructed by dividing the original series by these seasonal factors. A preliminary estimate of the trend cycle is obtained by applying a weighted moving average to this seasonally adjusted series (i.e. removing the irregular component from the seasonally adjusted series). In a similar manner, the trading day components are identified and removed also.



*Iteration 2 :* Using the same computations, a second iteration is performed on the original series that has been adjusted by both the trading day factors and irregular weights from iteration 1. Final estimates of the trading day factors and irregular weights are thereby produced.

*Iteration 3 :* The final iteration is performed using the original series that has been adjusted for trading day factors and irregular weights computed during the second iteration. Final estimates of seasonal factors, the seasonally adjusted series, trend cycle and irregular components are produced.

APPENDIX 6.3 : UNIT ROOT TESTS

Notation :     A : Akaike Information Criterion (1974)  
                  S : Schwartz Criterion (1978)  
                  H : Hannan-Quinn Criterion (1979)  
                  L : LM Test Decision<sup>1</sup>  
                  ln : Denotes the natural logarithm of a variable  
                  R : Denotes a real variable

All variable names are given in Section 6.4 of the main text. The variables in levels in the tables below appear in the form they will take in the cointegrating model of Chapter 7. The shaded cells in the tables below indicate the rejection of the null hypothesis of a unit root at the 5 per cent level, the ADF *t*-statistic being greater than the critical value. The tables would suggest that the ADF *t*-tests are strongly influenced by the choice of lag length, as we saw in Appendix 4.2.

WHOLE SAMPLE PERIOD : 1969Q1 - 1995Q4

Table A6.3.1a : ADF Unit Root *t*-Tests (with constant, no time trend) : Levels

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
lnR(AAPR)	-1.6282	-1.9484	-1.9491	-1.9035	-1.8683	-1.8723	-1.9083	-1.9627	-1.7959	1	1	1	0
R(Rm)	-1.2940	-1.6467	-1.5986	-1.7337	-1.0975	-1.2161	-1.5909	-1.2781	-1.0672	8	4	7	4
lnR(AAAU)	-2.8061	-1.7738	-1.6072	-1.3568	-1.4864	-1.6308	-1.7128	-1.7282	-1.5252	1	1	1	1
lnZLVF	-0.6324	-2.0808	-2.3367	-1.6709	-1.6468	-2.3404	-1.9375	-1.5095	-1.1477	8	1	5	5
lnCOLLAT	1.6190	-1.9910	-1.7791	-0.9154	-0.4948	-0.5149	-0.6021	-0.7769	-0.4693	4	3	4	3
lnR(PAHM)	-1.9960	-2.5043	-3.0647	-2.7418	-2.3118	-2.1965	-2.1831	-2.2313	-2.1008	4	2	4	3
lnR(ALDO)	0.7312	0.3445	0.3123	0.2077	0.5231	0.4077	0.4073	0.4516	0.4472	1	1	1	1
lnINFL	-0.6600	-1.1161	-1.2406	-1.3247	-0.3088	-0.7988	-1.0782	-1.0864	-0.3833	8	5	8	8
lnMIRAS	5.2119	0.0429	0.6584	0.4844	0.5241	3.0151	1.3140	0.7814	0.9733	7	6	6	6*
R(UC)	-1.8350	-3.7136	-3.0355	-2.5425	-2.4567	-2.4924	-2.1810	-1.8862	-1.6457	1	1	1	1

Critical value at the 5 per cent level of significance is -2.8906

Table A6.3.1b : ADF Unit Root *t*-Tests (with constant and time trend) : Levels

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
lnR(AAPR)	-0.6713	-1.2451	-1.2131	-1.0796	-0.9301	-0.9670	-1.0945	-1.2768	-0.5929	1	1	1	0
R(Rm)	-2.0495	-2.5623	-2.5325	-2.7617	-2.0306	-2.1707	-2.6473	-2.2492	-1.9434	7	4	6	6
lnR(AAAU)	-3.6013	-2.3973	-2.2172	-1.9181	-2.1079	-2.3576	-2.5342	-2.6138	-2.3754	1	1	1	1
lnZLVF	-1.6498	-3.0892	-3.4741	-2.7162	-2.7338	-3.8238	-3.3660	-2.8295	-2.3541	5	5	5	5
lnCOLLAT	-4.0735	-3.6792	-3.4928	-2.8415	-2.6829	-2.6667	-2.6525	-2.6433	-2.5268	4	4	4	3
lnR(PAHM)	-0.9133	-3.0463	-4.1585	-3.6503	-2.7909	-2.5660	-2.5998	-2.8187	-2.4385	4	2	2	2
lnR(ALDO)	-2.0653	-2.2558	-2.2632	-2.3184	-2.1410	-2.1658	-2.1450	-2.1114	-2.0899	1	1	1	1
lnINFL	-2.1321	-2.5660	-2.6944	-2.7908	-2.0635	-2.3546	-2.5611	-2.5598	-1.8908	8	5	8	8*
lnMIRAS	1.6526	-1.1783	-0.6120	-0.6805	-0.5750	1.3200	0.4899	0.2230	0.5103	6	6	6	6*
R(UC)	-2.9216	-3.6807	-3.0013	-4.5120	-4.5433	-4.7375	-4.4311	-4.1484	-3.8904	1	1	1	1

Critical value at the 5 per cent level of significance is -3.4552

<sup>1</sup> This is the first lag for which the null hypothesis of no autocorrelation in the residual series cannot be rejected. Under the null hypothesis the LM statistic will follow a  $\chi^2$  with 4 degrees of freedom; at the 5 per cent level of significance the critical value is 9.49. If serial correlation remains in the model for all lags of up to order 8, then the chosen lag length is that with the lowest LM test statistic and is indicated by a \*.



Table A6.3.1c : ADF Unit Root *t*-Tests (with constant, no time trend) : Differences

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
$\Delta \ln R(AAPR)$	-7.5396	-6.1094	-5.4780	-5.1716	-4.4441	-3.7074	-3.1357	-3.8903	-3.0539	0	0	0	0
$\Delta R(Rm)$	-7.9838	-6.4433	-5.6058	-6.7064	-5.1411	-3.6845	-4.1543	-4.4583	-4.0417	7	3	6	5
$\Delta \ln R(AAAU)$	-15.026	-9.0830	-7.7179	-5.6298	-4.2956	-3.6732	-3.3879	-3.6872	-3.6189	0	0	0	0
$\Delta \ln ZLVF$	-5.6297	-4.5955	-5.4838	-4.7854	-3.1677	-3.6078	-4.2134	-4.7817	-3.8272	7	0	7	5
$\Delta \ln COLLAT$	-1.5481	-1.6977	-2.5532	-3.0955	-2.8910	-2.6100	-2.3195	-2.6770	-1.9567	8	3	3	2
$\Delta \ln R(PAHM)$	-3.4253	-2.5260	-2.9473	-3.8128	-3.8961	-3.6450	-3.2336	-3.6188	-3.0819	3	3	3	3
$\Delta \ln R(ALDO)$	-7.6317	-5.8582	-4.6477	-5.1103	-4.1790	-3.8077	-3.6028	-3.3439	-2.9192	0	0	0	0
$\Delta \ln INFL$	-7.7734	-5.8598	-4.9085	-6.6999	-4.5956	-3.7671	-3.5297	-4.5767	-3.1891	8	4	8	7
$\Delta \ln MIRAS$	-2.5614	-3.0054	-2.5745	-2.4631	-4.9212	-2.3000	-1.7076	-1.8574	-3.1348	8	8	8	8*
$\Delta R(UC)$	-5.3955	-5.9718	-6.2225	-5.5826	-4.9249	-5.0860	-5.0123	-5.1375	-4.4276	2	1	2	0

Critical value at the 5 per cent level of significance is -2.8909

Table A6.3.1d : ADF Unit Root *t*-Tests (with constant and time trend) : Differences

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
$\Delta \ln R(AAPR)$	-7.6643	-6.2666	-5.6762	-5.4244	-4.7117	-3.9519	-3.3637	-4.2680	-3.3516	0	0	0	0
$\Delta R(Rm)$	-7.9420	-6.4065	-5.0344	-6.6677	-5.1038	-3.6442	-4.1129	-4.4167	-4.0053	7	3	6	5
$\Delta \ln R(AAAU)$	-14.948	-9.0351	-7.6766	-5.5994	-4.2723	-3.6530	-3.3686	-3.6669	-3.5989	0	0	0	0
$\Delta \ln ZLVF$	-5.6514	-4.6231	-5.5095	-4.8161	-3.2087	-3.6383	-4.2355	-4.8048	-3.8540	7	0	7	6
$\Delta \ln COLLAT$	-1.4763	-1.6739	-2.7379	-3.4563	-3.2738	-2.9751	-2.6188	-3.2164	-2.3141	8	3	3	2
$\Delta \ln R(PAHM)$	-3.4736	-2.5824	-3.0123	-3.8895	-3.9882	-3.7441	-3.3350	-3.7221	-3.1869	3	3	3	3
$\Delta \ln R(ALDO)$	-7.7780	-6.0241	-4.8203	-5.3604	-4.4298	-4.0809	-3.9120	-3.6781	-3.2325	0	0	0	0
$\Delta \ln INFL$	-7.7857	-5.8787	-4.9322	-6.8676	-4.6811	-3.8220	-3.5909	-4.7362	-3.3228	8	3	8	7
$\Delta \ln MIRAS$	-3.5129	-4.1231	-3.7048	-3.6557	-7.6531	-4.1355	-3.3898	-3.7552	-6.0896	8	8	8	8*
$\Delta R(UC)$	-5.3689	-5.9431	-6.1963	-5.5615	-4.9062	-5.0745	-5.0115	-5.1435	-4.4397	2	1	2	0

Critical value at the 5 per cent level of significance is -3.4557

FIRST SUBSAMPLE PERIOD : 1969Q1 - 1983Q4

Table A6.3.2a : ADF Unit Root *t*-Tests (with constant, no time trend) : Levels

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
lnR(AAPR)	-1.7995	-2.5435	-2.7219	-2.1946	-2.1645	-2.2044	-2.2998	-2.3623	-2.1784	8	1	1	1
R(Rm)	-0.5850	-1.1779	-1.2993	-1.4473	-0.7614	-0.9758	-1.5625	-0.9513	-0.7340	7	1	1	1
lnR(AAAU)	-3.1447	-2.0893	-2.0306	-1.7778	-1.7023	-1.7588	-1.8248	-1.8048	-1.7052	1	1	1	1
lnZLVF	-0.9176	-2.3687	-2.6118	-2.0726	-2.1516	-3.6139	-3.0646	-2.3100	-1.8272	5	1	5	5
lnCOLLAT	-1.9366	-3.8796	-3.3009	-2.2785	-2.1442	-2.1215	-2.1332	-2.0912	-1.9789	4	3	3	3
lnR(PAHM)	-2.2866	-4.3069	-5.3959	-4.7461	-3.9984	-3.9346	-3.8705	-4.1121	-4.0452	2	2	2	2
lnR(ALDO)	-0.2276	-1.6014	-1.5306	-1.5647	-0.8908	-1.1223	-1.2632	-1.2519	-0.9179	1	1	1	1
lnINFL	-0.4055	-1.3752	-1.5893	-1.5578	-1.2415	-1.5804	-1.5548	-1.4548	-1.0896	1	1	1	1
lnMIRAS	-1.3343	-2.7088	-2.5182	-2.6312	-2.6627	-2.2200	-2.0759	-2.0275	-2.1171	7	5	7	7*
R(UC)	-1.3932	-3.3965	-2.7209	-2.4694	-2.5644	-2.5326	-2.1972	-1.8062	-1.6201	1	1	1	1

Critical value at the 5 per cent level of significance is -2.9190

Table A6.3.2b : ADF Unit Root *t*-Tests (with constant and time trend) : Levels

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
lnR(AAPR)	-2.0519	-3.0671	-3.4381	-2.8272	-2.8612	-3.0543	-3.3836	-3.7434	-2.7841	8	1	8	1
R(Rm)	-1.2697	-1.6887	-1.7540	-1.8527	-1.2299	-1.3094	-1.7628	-1.1442	-0.8821	7	1	1	1
lnR(AAAU)	-3.7844	-2.2286	-2.2013	-1.7100	-1.5721	-1.8586	-2.1988	-2.3026	-2.2086	1	1	1	1
lnZLVF	-1.2430	-2.5257	-2.7298	-2.1710	-2.1927	-3.5904	-3.0023	-2.1909	-1.6577	5	1	5	5
lnCOLLAT	-1.7163	-3.8477	-3.2409	-1.0835	-0.4716	-0.2793	-0.0075	-0.0625	-0.6208	4	3	3	3
lnR(PAHM)	-2.0753	-4.2044	-5.3091	-4.6212	-3.7245	-3.6353	-3.5492	-3.8424	-3.7832	2	2	2	2
lnR(ALDO)	-0.6432	-1.8492	-1.7285	-1.7189	-1.0136	-1.1719	-1.2625	-1.1922	-0.7774	1	1	1	1
lnINFL	-0.5088	-1.3405	-1.4504	-1.3420	-0.8744	-1.2114	-1.1102	-0.9196	-0.3624	1	1	1	1
lnMIRAS	-0.2166	-2.7107	-2.4761	-2.7190	-2.8946	-0.6204	-0.7603	-1.2404	-1.4625	7	5	7	7*
R(UC)	-2.2386	-4.5474	-3.8986	-3.6648	-3.7571	-3.7040	-3.3263	-2.8657	-2.6067	1	1	1	1

Critical value at the 5 per cent level of significance is -3.4987

Table A6.3.2c : ADF Unit Root *t*-Tests (with constant, no time trend) : Differences

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
ΔlnR(AAPR)	-4.8137	-4.0674	-4.7932	-4.2938	-3.6439	-3.0427	-2.7329	-4.3533	-3.0798	8	0	7	0
ΔR(Rm)	-5.3118	-4.0787	-3.3190	-4.2230	-3.3234	-2.3482	-2.9682	-3.0127	-2.4690	6	0	0	0
ΔlnR(AAAU)	-12.019	-6.4887	-5.8367	-4.8079	-3.4340	-2.7006	-2.4905	-2.6369	-2.4065	0	0	0	0
ΔlnZLVF	-3.5780	-3.1602	-3.5535	-3.2338	-2.2020	-2.6516	-3.2933	-3.6553	-2.7490	7	0	0	0
ΔlnCOLLAT	-0.9789	-1.3436	-2.2615	-3.0535	-2.7329	-2.5170	-1.9489	-2.4772	-1.7849	3	2	2	2
ΔlnR(PAHM)	-2.1368	-1.8859	-2.4388	-3.2297	-3.0830	-2.9745	-2.5691	-2.6236	-2.3813	3	0	3	2
ΔlnR(ALDO)	-3.8449	-3.5619	-3.1677	-3.9342	-3.0052	-2.4998	-2.3525	-2.7061	-2.3079	0	0	0	0
ΔlnINFL	-4.4488	-3.5945	-3.3066	-3.8248	-2.7567	-2.5941	-2.5884	-2.9152	-1.9661	0	0	0	0
ΔlnMIRAS	-2.3090	-2.4072	-2.1905	-2.1088	-3.3956	-3.2883	-2.0035	-1.8143	-2.9653	8	8	8	8
ΔR(UC)	-3.4069	-4.0088	-4.0655	-3.5736	-3.3751	-3.5940	-3.3328	-3.5809	-2.8264	1	0	1	0

Critical value at the 5 per cent level of significance is -2.9202

Table A6.3.2d : ADF Unit Root *t*-Tests (with constant and time trend) : Differences

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
ΔlnR(AAPR)	-4.7480	-4.0233	-4.7531	-4.2555	-3.5957	-2.9825	-2.6607	-4.2660	-2.9492	8	0	7	0
ΔR(Rm)	-5.3755	-4.1537	-3.4024	-4.4617	-3.5379	-2.4691	-3.2151	-3.3457	-2.8143	6	0	0	0
ΔlnR(AAAU)	-12.106	-6.5989	-6.0038	-5.0270	-3.6520	-2.9226	-2.7266	-2.8975	-2.6653	0	0	0	0
ΔlnZLVF	-3.6019	-3.1937	-3.6287	-3.3342	-2.2759	-2.7466	-3.4239	-3.8431	-2.9589	7	0	0	0
ΔlnCOLLAT	-1.8822	-2.2004	-3.5738	-4.1478	-3.9251	-3.8244	-3.2976	-4.1966	-3.5167	7	3	3	2
ΔlnR(PAHM)	-2.1752	-1.9244	-2.4974	-3.3874	-3.2801	-3.1955	-2.8001	-2.8457	-2.6121	3	3	3	2
ΔlnR(ALDO)	-4.0068	-3.7524	-3.3763	-4.2576	-3.3331	-2.8385	-2.7163	-3.1665	-2.7920	3	0	0	0
ΔlnINFL	-4.6079	-3.7582	-3.5088	-4.1621	-2.9956	-2.8693	-2.9181	-3.3832	-2.4381	0	0	0	0
ΔlnMIRAS	-2.6048	-2.7313	-2.5198	-2.4502	-6.4756	-4.2579	-2.8197	-2.6584	-3.8723	8	8	8	8
ΔR(UC)	-3.4274	-4.0295	-4.0928	-3.6187	-3.4462	-3.7468	-3.8269	-3.9432	-3.2013	1	1	1	0

Critical value at the 5 per cent level of significance is -3.5005



SECOND SUBSAMPLE PERIOD : 1984Q1 - 1995Q4

Table A6.3.3a : ADF Unit Root *t*-Tests (with constant, no time trend) : Levels

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
lnR(AAPR)	-0.1976	-0.5083	-0.4269	-0.5315	-0.4324	-0.5359	-0.6367	-0.8281	-0.6069	0	0	0	0
R(Rm)	-2.7142	-3.2989	-2.9955	-3.4607	-2.0849	-2.1330	-2.4489	-2.4328	-2.0799	4	0	4	4
lnR(AAAU)	-0.8415	-0.6412	-0.2203	-0.3753	-0.7492	-0.8590	-0.8699	-0.7597	-0.3606	4	0	0	0
lnZLVF	-0.1503	-1.3866	-2.0783	-1.1707	-1.0803	-1.6801	-1.6583	-1.7760	-1.5712	5	1	5	3
lnCOLLAT	-4.4179	-2.2339	-2.1374	-2.1435	-2.5193	-2.5727	-2.5916	-2.7386	-3.4930	1	1	1	1
lnR(PAHM)	-1.8716	-1.8399	-2.2990	-2.3595	-2.1838	-2.0871	-2.1721	-2.2327	-1.8603	2	2	2	2
lnR(ALDO)	-1.5189	-1.5606	-1.6524	-1.6386	-1.9083	-1.7736	-1.7805	-1.9215	-1.8649	0	0	0	0
lnINFL	-1.1448	-1.2803	-1.2794	-1.4204	-0.1541	-0.1556	-0.6144	-0.8844	-0.2002	8	0	8	6
lnMIRAS	4.2225	0.2486	0.9966	0.8445	0.9977	2.9792	1.3665	1.3501	1.6639	6	6	6	1*
R(UC)	-1.6646	-2.9804	-2.5381	-2.0527	-1.8632	-1.9604	-1.7848	-1.6436	-1.4340	1	1	1	1

Critical value at the 5 per cent level of significance is -2.9228

Table A6.3.3b : ADF Unit Root *t*-Tests (with constant and time trend) : Levels

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
lnR(AAPR)	-1.7172	-1.7900	-1.6650	-1.6907	-1.5637	-1.5739	-1.5839	-1.6549	-1.4497	0	0	0	0
R(Rm)	-2.7865	-3.3862	-3.0931	-3.3327	-2.1815	-2.2146	-2.4910	-2.4528	-2.0991	4	1	4	4
lnR(AAAU)	-1.7523	-1.5429	-1.1386	-1.2814	-1.6916	-1.8017	-1.8071	-1.6860	-1.3253	4	0	0	0
lnZLVF	-0.2236	-1.0183	-1.8924	-0.3581	-0.0952	-1.2211	-1.2575	-1.4530	-1.3420	5	1	5	3
lnCOLLAT	0.7345	-1.2989	-1.7001	-1.5915	-1.3615	-1.3452	-1.3457	-1.4072	-1.5034	2	1	1	1
lnR(PAHM)	-0.4393	-1.2694	-1.9670	-2.0490	-1.7205	-1.5007	-1.6394	-1.7746	-1.1666	2	2	2	2
lnR(ALDO)	-2.2489	-2.0414	-1.7908	-1.7691	-1.5394	-1.5714	-1.5281	-1.4377	-1.4220	0	0	0	0
lnINFL	-1.7523	-1.8808	-1.8563	-2.0183	-0.5024	-0.7554	-1.2323	-1.6539	-0.8469	8	0	8	8
lnMIRAS	-0.6886	-2.0689	-1.4201	-1.5159	-1.3369	-0.1045	-0.9297	-0.8745	-0.5415	6	6	6	1*
R(UC)	-1.9846	-3.5008	-3.0793	-2.5782	-2.4028	-2.5537	-2.3894	-2.2506	-2.0295	1	1	1	1

Critical value at the 5 per cent level of significance is -3.5045

Table A6.3.3c : ADF Unit Root *t*-Tests (with constant, no time trend) : Differences

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
ΔlnR(AAPR)	-5.7008	-4.5366	-3.4560	-3.2253	-2.6279	-2.2282	-1.7880	-1.9952	-1.5149	0	0	0	0
ΔR(Rm)	-6.1663	-5.4128	-4.0636	-5.9918	-4.4377	-3.3042	-3.0963	-3.5001	-3.2940	3	3	3	3
ΔlnR(AAAU)	-7.5640	-6.5456	-4.0055	-2.5264	-2.1771	-2.0323	-2.0602	-2.4339	-2.3217	1	1	1	0
ΔlnZLVF	-4.9490	-3.5759	-4.5343	-3.6551	-1.7899	-1.6948	-1.3166	-1.5821	-1.3154	4	0	2	2
ΔlnCOLLAT	-1.2542	-0.8184	-0.8536	-1.1527	-1.0713	-0.9460	-0.8985	-1.2491	-0.6681	0	0	0	0
ΔlnR(PAHM)	-2.8326	-1.6467	-1.5519	-1.7877	-1.8803	-1.6671	-1.5209	-1.8875	-1.5509	1	1	1	1
ΔlnR(ALDO)	-7.7073	-5.9094	-4.3218	-4.2531	-3.2101	-2.8396	-2.7648	-2.3740	-1.8505	0	0	0	0
ΔlnINFL	-6.4209	-4.7360	-3.6985	-5.7643	-3.8576	-2.8234	-2.3537	-3.2318	-2.3895	8	3	8	5
ΔlnMIRAS	-1.9619	-2.5102	-2.0467	-2.0136	-3.4580	-1.4626	-1.3158	-1.4371	-2.6256	8	8	8	0*
ΔR(UC)	-4.2177	-4.4149	-4.6486	-4.2608	-3.4942	-3.4210	-3.3139	-3.3523	-2.9763	2	0	0	0

Critical value at the 5 per cent level of significance is -2.9228

Table A6.3.3d : ADF Unit Root *t*-Tests (with constant and time trend) : Differences

Variable	Lags									Lag Criteria			
	0	1	2	3	4	5	6	7	8	A	S	H	L
ΔlnR(AAPR)	-6.0966	-5.0353	-3.9793	-3.8113	-3.2333	-2.8499	-2.3881	-2.7899	-2.1657	0	0	0	0
ΔR(Rm)	-6.0955	-5.3484	-3.9939	-5.9141	-4.3788	-3.2345	-3.0192	-3.4940	-3.3162	3	3	3	3
ΔlnR(AAAU)	-7.5960	-6.6450	-4.1146	-2.6381	-2.2992	-2.1682	-2.2272	-2.6917	-2.6234	1	1	1	0
ΔlnZLVF	-5.0636	-3.6576	-4.7262	-3.9212	-2.0807	-1.9572	-1.5213	-1.6577	-1.2989	4	2	2	2
ΔlnCOLLAT	-2.1424	-1.6845	-1.7527	-2.3008	-2.3301	-2.2978	-2.4069	-3.2700	-2.3806	0	0	0	0
ΔlnR(PAHM)	-3.2549	-1.9823	-1.8943	-2.2042	-2.3638	-2.1550	-2.0087	-2.3774	-2.0749	1	1	1	0
ΔlnR(ALDO)	-7.7671	-6.0451	-4.4862	-4.5608	-3.4955	-3.1512	-3.1734	-2.8010	-2.1891	0	0	0	0
ΔlnINFL	-6.4554	-4.8072	-3.7802	-6.0125	-4.1026	-3.0645	-2.6030	-3.3993	-2.5617	8	3	8	6
ΔlnMIRAS	-2.4423	-3.2673	-2.8239	-2.8844	-5.4434	-2.8457	-2.7331	-2.9544	-3.9717	8	8	8	8
ΔR(UC)	-4.1810	-4.3700	-4.6014	-4.2154	-3.4607	-3.3921	-3.3000	-3.3367	-2.9639	2	0	0	0

Critical value at the 5 per cent level of significance is -3.5045

Where the findings presented in the tables above suggest either that a variable in levels is stationary or its first difference is non-stationary, this will obviously cause problems for the inclusion of the relevant variable in levels in a cointegrating relationship. In such cases, additional ADF  $F$ -tests are undertaken (see Section 4.3.3.1 of Chapter 4 for a discussion of the  $F$ -test) for the joint significance of *both* the lagged dependent variable and the deterministic time trend in the ADF regressions. However, with very few exceptions, the results appear to confirm the results of the  $t$ -tests presented above.

As a final check, Phillips-Perron (PP) tests are computed *only* for those variables for which the optimal lag choice suggests that either its level is stationary or its difference non-stationary. For the whole sample period, PP tests<sup>2</sup> (conducted using lags of up to order 8) indicate that the variables  $\ln ZLVF$ ,  $\ln R(PAHM)$  and  $R(UC)$  are non-stationary (as required). However, according to the PP tests the first difference in the variable  $\ln COLLAT$  is non-stationary suggesting that  $\ln COLLAT$  could be integrated of order 2 or higher.

For the first subsample period, PP tests suggest that the variables  $\ln ZLVF$ ,  $\ln R(PAHM)$  and  $R(UC)$  are non-stationary as expected, but that the first differences of  $\ln COLLAT$  and  $\ln R(PAHM)$  are non-stationary (possibly suggesting integration of order 2 in the level series). Finally, for the second subsample period, PP tests suggest that  $R(UC)$  is non-stationary as required. The first difference in the variable  $\ln COLLAT$  appears non-stationary, the first difference in  $\ln INFL$  is stationary,  $\Delta \ln MIRAS$  is stationary at the 10 per cent level (when the Akaike, Schwartz or Hannan-Quinn criteria are used to determine the optimal lag length) and the first difference in  $\ln R(PAHM)$  is non-stationary for lags 1-4 and stationary for lags 5-8. Given that the highest significant lag order from either the autocorrelation or partial autocorrelation function is fairly low, one could argue that the first difference in  $\ln R(PAHM)$  is non-stationary (again suggesting integration of order 2 in the level series).

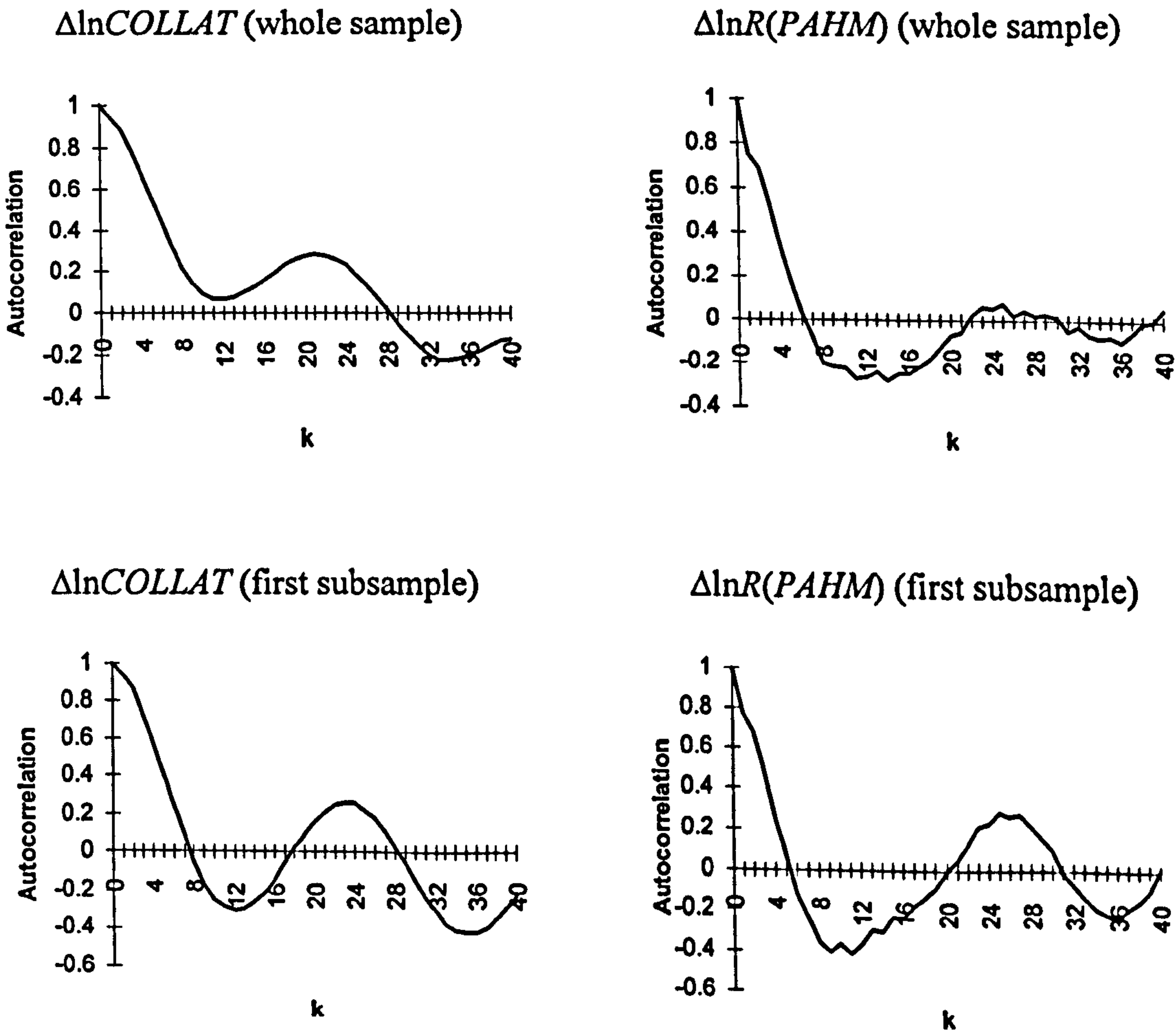
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<sup>2</sup> Phillips-Perron  $F$ -tests are conducted for the joint significance of the lagged dependent variable and a time trend, and  $t$ -tests are conducted for regressions which include a constant, and a constant and time trend. The output results are lengthy and thus are omitted from the appendix.



From the above discussion of the ADF and PP unit root  $F$  and  $t$ -tests, it is reasonable to conclude that all of the level variables are  $I(1)$  with the exceptions of  $\ln COLLAT$  and  $\ln R(PAHM)$  which, the results suggest, are integrated of at least order 2 since their differences are found to be non-stationary. Graphical evidence on both of these variables is presented below. If the autocorrelation function of a variable declines quickly as the lag length ( $k$ ) rises then the variable will most likely be stationary (in fact an autocorrelation function declining geometrically to zero will be strong evidence for stationarity). The evidence presented below would tend to suggest that first differences of these series are  $I(0)$  (rather than non-stationary as the formal tests suggest), allowing us to conclude that the level series are indeed integrated of order 1.

Figure A6.3.1 : Autocorrelation Functions of Variables with Unclear ADF Tests



$\Delta \ln COLLAT$  (second subsample)

$\Delta \ln R(PAHM)$  (second subsample)

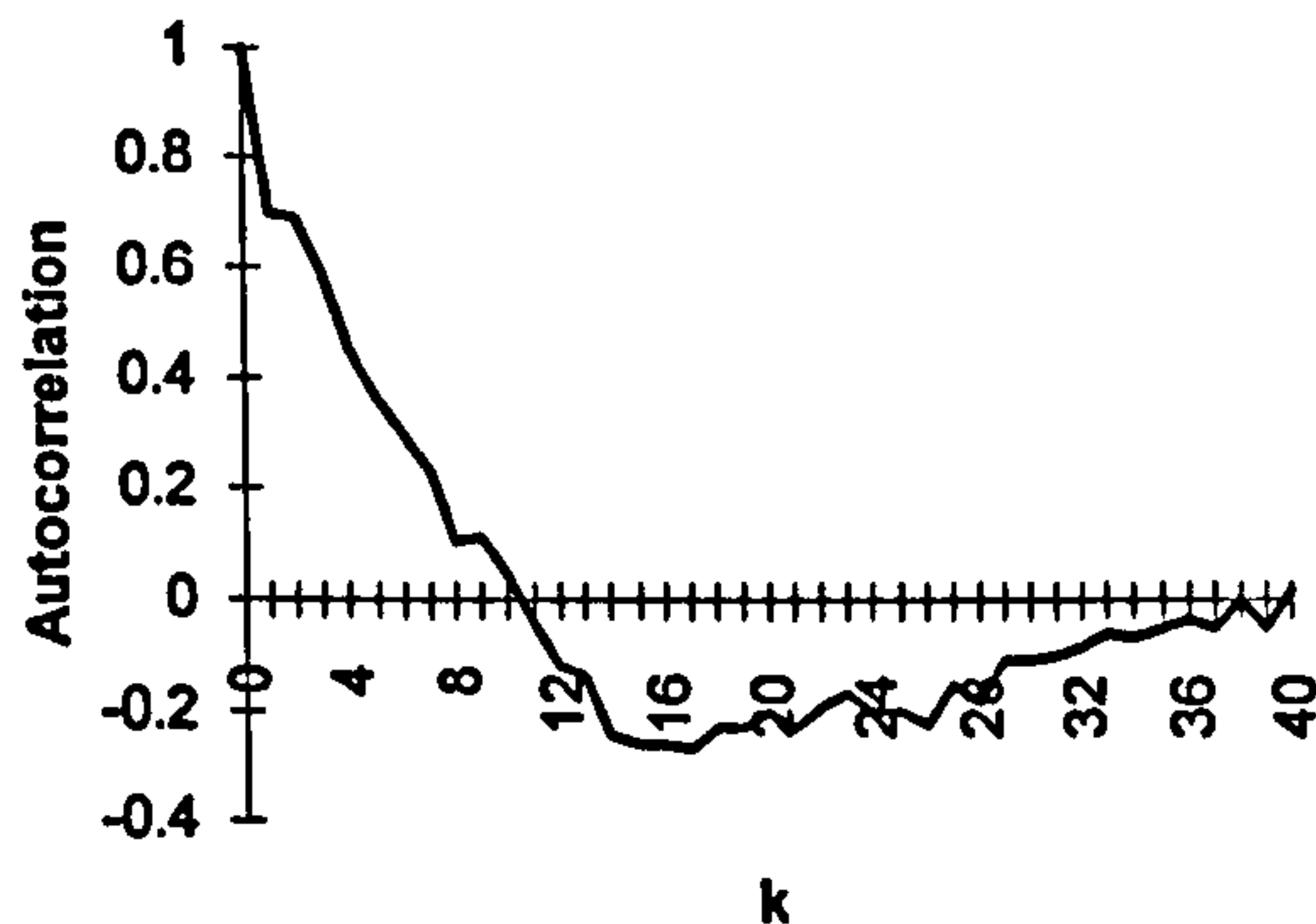
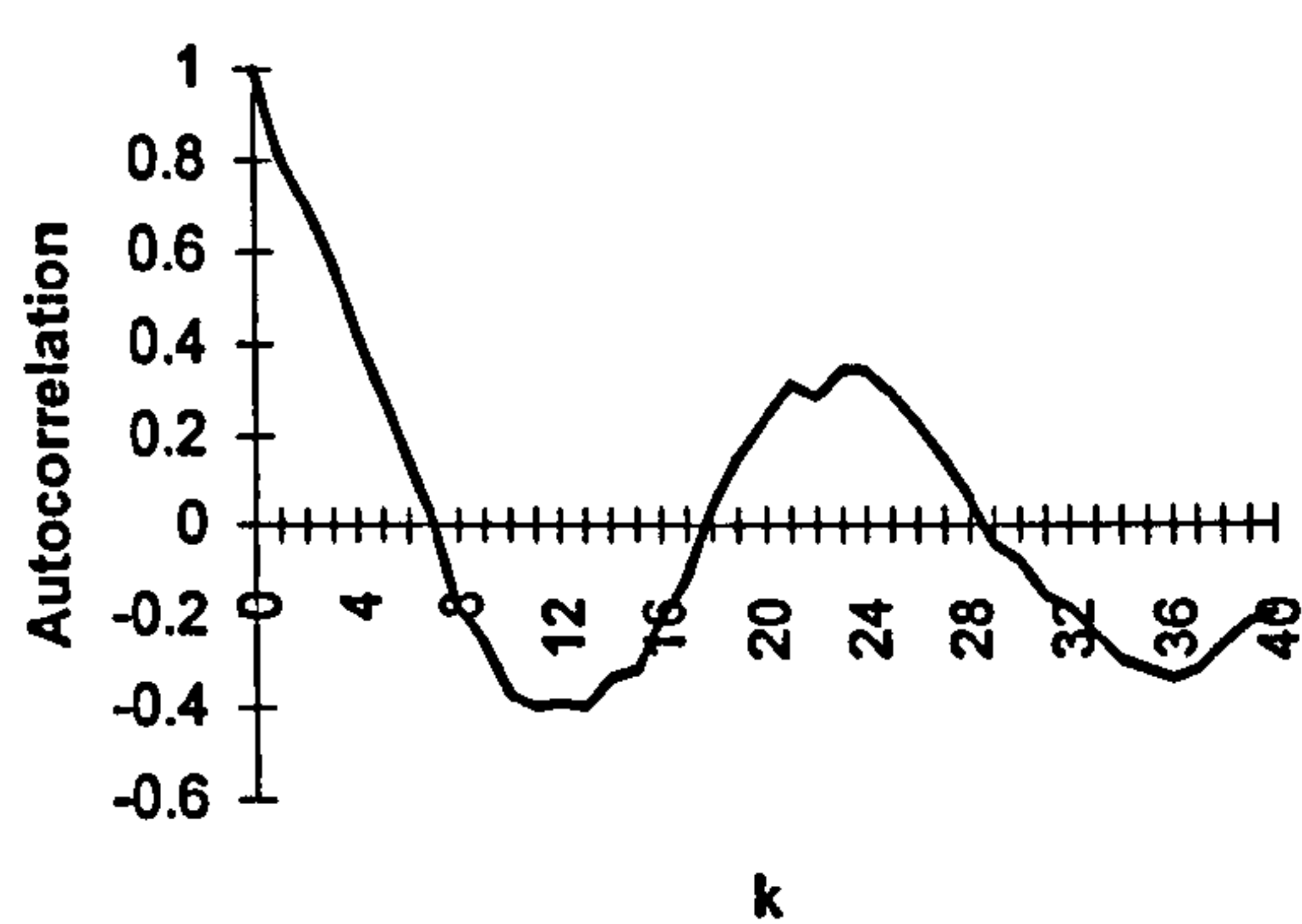
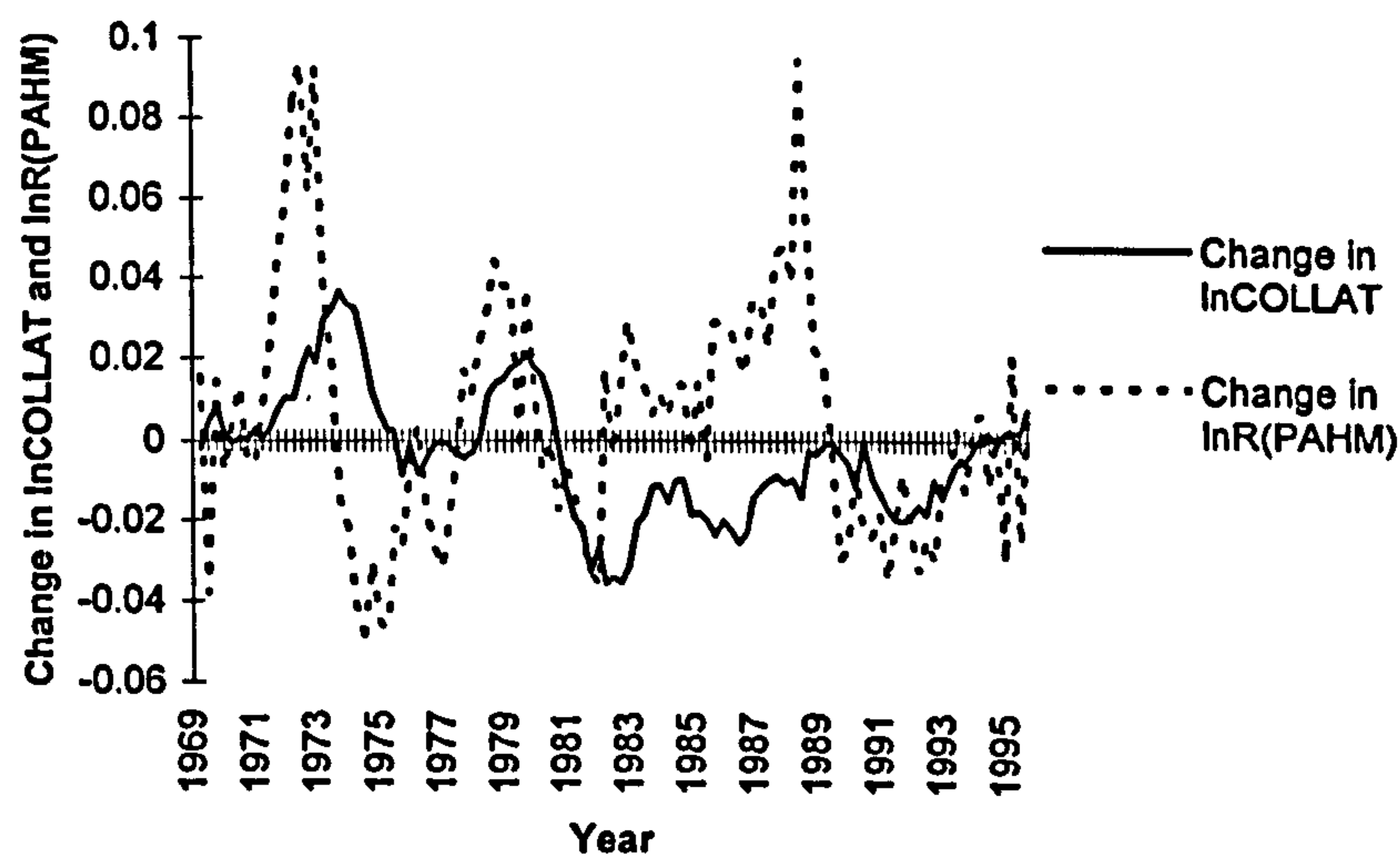


Figure A6.3.2 : A Plot of  $\Delta \ln COLLAT$  and  $\Delta \ln R(PAHM)$





APPENDIX TO CHAPTER 7

APPENDIX 7.1 : LM TESTS FOR RESIDUAL SERIAL CORRELATION OF THE UNDERLYING VAR EQUATIONS

Table A7.1.1 : LM Test Statistics on the Residuals of the Individual Equations of the Underlying Complete System VAR with 1 Lag

Sample Period	lnR(AAPR)	R(Rm)	lnZLVF	lnCOLLAT	lnR(AAAU)	lnR(PAHM)	lnR(ALDO)	lnINFL	lnMIRAS	R(UC)	Number not Significant*
1969Q1-1995Q4	6.1293	31.1415	17.7349	57.7396	5.8164	3.3302	11.6715	28.4581	54.2878	35.6617	3/10
1969Q1-1983Q4	11.8203	23.7563	10.6537	23.0313	15.7913	3.5698	13.4381	14.8108	15.3010	23.9853	1/10
1984Q1-1995Q4	15.5805	23.6891	24.3315	10.6277	17.1639	6.4561	9.4883	24.2598	17.6428	18.1786	2/10

\* i.e. the number of equations with no residual serial correlation at the 5 per cent level of significance

Table A7.1.2 : LM Test Statistics on the Residuals of the Individual Equations of the Underlying Complete System VAR with 2 Lags

Sample Period	lnR(AAPR)	R(Rm)	lnZLVF	lnCOLLAT	lnR(AAAU)	lnR(PAHM)	lnR(ALDO)	lnINFL	lnMIRAS	R(UC)	Number not Significant*
1969Q1-1995Q4	2.5385	29.4843	17.1632	11.8371	5.2923	9.8750	12.4649	21.3089	44.5549	4.9066	3/10
1969Q1-1983Q4	19.6893	26.5775	19.1820	30.0239	28.7543	12.7907	19.3206	19.0737	34.1588	9.1733	1/10
1984Q1-1995Q4	20.5881	23.9540	26.8661	18.6401	19.1951	11.5696	28.6574	28.3124	28.4753	14.3188	0/10

Table A7.1.3 : LM Test Statistics on the Residuals of the Individual Equations of the Underlying Complete System VAR with 3 Lags

Sample Period	lnR(AAPR)	R(Rm)	lnZLVF	lnCOLLAT	lnR(AAAU)	lnR(PAHM)	lnR(ALDO)	lnINFL	lnMIRAS	R(UC)	Number not Significant*
1969Q1- 1995Q4	11.9310	29.0751	26.1517	4.4739	8.2695	7.7555	13.1074	30.2951	46.1278	8.4781	4/10
1969Q1- 1983Q4	26.7396	16.0445	35.4159	27.9149	34.1103	19.5087	27.4135	17.6997	40.5236	11.9359	0/10
1984Q1- 1995Q4	25.3009	42.3475	33.8412	35.4145	33.2247	29.1057	38.3480	36.4583	32.5426	31.0671	0/10

Table A7.1.4 : LM Test Statistics on the Residuals of the Individual Equations of the Underlying Complete System VAR with 4 Lags

Sample Period	lnR(AAPR)	R(Rm)	lnZLVF	lnCOLLAT	lnR(AAAU)	lnR(PAHM)	lnR(ALDO)	lnINFL	lnMIRAS	R(UC)	Number not Significant*
1969Q1- 1995Q4	11.4336	14.4450	29.8710	7.9824	16.0342	9.2723	12.2977	18.1966	29.8737	4.5507	3/10
1969Q1- 1983Q4	45.2198	50.0465	45.2696	38.0897	46.0800	39.2451	43.9771	46.0809	50.3926	41.7821	0/10
1984Q1- 1995Q4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A